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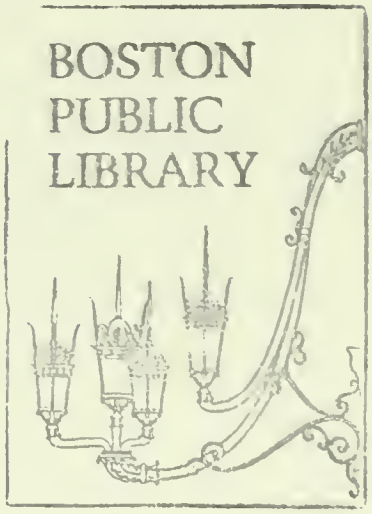
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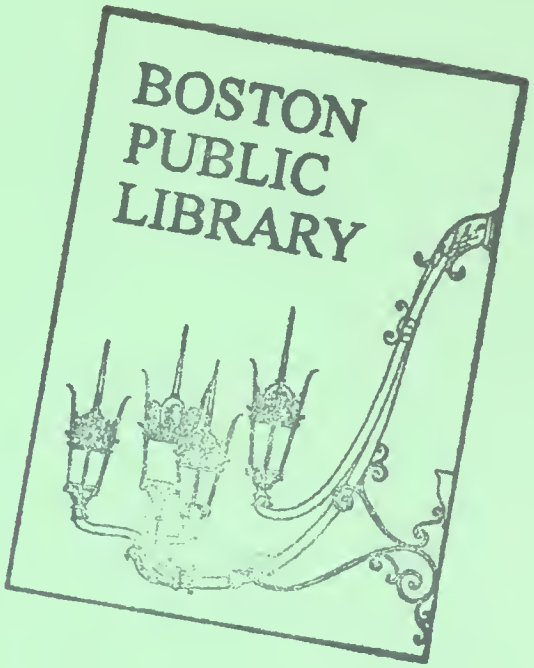
I-93 CENTRAL ARTERY (NORTH-CAUSEWAY)
DESIGN CONTRACT D015A
PRELIMINARY DESIGN REPORT

JANUARY, 1991



COMMONWEALTH OF MASSACHUSETTS

CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT

I-93 CENTRAL ARTERY (NORTH-CAUSEWAY)
DESIGN CONTRACT D015A
PRELIMINARY DESIGN REPORT

JANUARY, 1991

PREPARED FOR THE DEPARTMENT OF PUBLIC WORKS
BY BECHTEL/PARSONS BRINCKERHOFF

Leslie E. Tuplin
Design Engineer

J. J. Brunetti, P. E.
Area Design Manager

K. K. See-Tho, P.E.
Design Manager

I-93 CENTRAL ARTERY
CONTRACT D015A
PRELIMINARY DESIGN REPORT

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1.0 General

1.1 Purpose of Report

The purpose of this report is to supplement the Preliminary Design drawings and other documents in order to provide the Section Design Consultant (SDC) with additional information to perform final design. The report also provides background information which would not otherwise be available to the SDC.

1.2 Preliminary Design Drawings

The Preliminary Design drawings for this contract are organized into four major sections consisting of four volumes:

- Volume I - Preliminary Engineering Drawings including General, Survey, Civil, Utilities, Traffic, Architecture (Highways, Vent Building #4, Emergency Station #7, and Landscape) and Right-of-Way.
- Volume II - Structure Design Data Sheets - Tunnels
- Volume III - Structure Design Data Sheets - Vent Building #4 and Emergency Station #7
- Volume IV - Structure Design Data Sheets - Underpinning

1.3 DESCRIPTION OF THE DESIGN CONTRACT

1.3.1 Location Description

The project area is located wholly within the limits of the City of Boston, Suffolk County, Massachusetts along the corridor of the existing Central Artery I-93 Viaduct in downtown Boston. The general limits of the work extend from the interface with the proposed Design Section D017A at North Street to the interface with the proposed I-93 Central Artery Design Section D019B at approximate station 168+50, North of Causeway Street.

1.3.2 Design Description

The proposed I-93 Central Artery-North to Causeway Design Package consists of the type of construction outlined below. It includes mainline tunnel structures, entrance/exit ramps and connectors, tunnel emergency access/egress, and the design of a surface street system.

Design responsibilities include, but are not limited to the following:

a. Approximately 2,300 LF of mainline Cut-and-Cover tunnel construction varying from 8-10 lanes in width.

b. Approximately 800 LF of 1-2 lane ramp tunnels of Cut-and-Cover construction.

c. Approximately 1,800 LF of open/depressed sections, varying from 1-4 lanes in width.

d. Approximately 5,600 LF of At-Grade roadways, varying from 1-4 lanes in width.

e. Ventilation building #4 on the Parcel 7 site's to include a major subgrade structure to house exhaust and supply air fans and associated electrical equipment; 125-foot-high exhaust stacks; 4-story above grade fresh air intake duct structure; and below grade duct structures connecting the ventilation building to the tunnel. Ventilation equipment will be designed and installed under separate contracts. Coordination of space requirements, and inclusion of required embedded items will be part of this contract. The vent building will also incorporate a six-story commercial office building and ground floor marketplace building shell as part of this contract. Fire protection and HVAC systems for the commercial space and vent structures are part of this contract. Schematic architectural features of the commercial space will be provided to the Section Design Consultant to assure compatibility with the adjacent Parcel 7 parking garage being designed and constructed under separate contracts.

f. Operations and maintenance facilities.

g. Underpinning, surface bracing and support systems for the existing Central Artery Viaduct, including protection of adjacent structures and buildings.

h. Protection and maintenance of utilities, and utility relocation where required.

i. Site preparation.

j. Surface drainage systems, including pump stations if required.

k. Temporary facilities, including ramps and decking for traffic maintenance, traffic signals and street lighting.

l. Demolition of the existing Central Artery Viaduct.

m. Landscape design, including interim designs for the street system, where required.

n. Highway architecture.

o. Tunnel finishes.

p. Embedded items for highway communications and power systems.

q. Signage.

r. Construction sequencing, including interface requirements between adjacent contracts, and protection and maintenance of vehicle and pedestrian traffic.

s. Construction mitigation in accordance with requirements of the SEIS, and current mitigation guidelines.

t. Coordination, interface and liason functions with other Section Design Consultants, Review Agencies, etc.

1.4 Interface with Adjacent Design and Construction Contracts

The Downtown D015A contract area is home to many adjacent design and construction contracts. This section provides a description of these major interfaces tasks.

1.4.1 Area Geotechnical Consultant (Contract G023D)

The scope of work of the Area Geotechnical Consultant (AGC) involves the planning and implementing of a field exploration program (borings and test pits), performing laboratory tests, and providing a report that includes recommendations for geotechnical aspects of the design. The AGC's report is expected to include earth pressure diagrams, recommendations for foundation types and other parameters for design, and recommendations to mitigate adverse effects during construction. For the D015A design section, the primary AGC is GEI Consultants. However, for a small portion of the D015A section north of Causeway Street, the AGC is Stone & Webster, Inc.

The SDC is not expected to develop geotechnical recommendations, but rather to implement them. For example, the AGC will provide soil properties and extra pressures for the design of the tunnel walls, but it will be the SDC's responsibility to perform analysis and designs based on those recommendations. These analysis will require the SDC to have "in-house" geotechnical expertise to perform the analysis and evaluate the results. In as much as design is an intensive process, the SDC will also need to have "in-house" geotechnical expertise to evaluate whether the parameters supplied by the AGC are leading to a reasonable design. If not, then this may lead the SDC to request that the AGC reevaluate their recommendations.

The scope of work of the SDC will involve reviewing and using the geotechnical data and recommendations provided by the AGC. The SDC will be expected to evaluate whether the field and laboratory data, and the recommendations provided are sufficient to complete the design. If a need for additional data or recommendations is ascertained, the SDC should then submit a request to B/PB, who will review the request, and then authorize the AGC to perform any additional work that may be necessary. Within the AGC's scope of work, there is time and budget

allocated to support the SDC during the design. The role of B/PB, and specifically the B/PB Geotechnical Department, is to assist in managing the work of the AGC and providing coordination between the AGC and the SDC.

Because matters involving scheduling, the field work and the AGC final report for D015A will probably not be available at the NTP date for the SDC. However, there are provisions whereby the AGC will provide preliminary recommendations to the SDC so as not to delay the SDC's work. This will involve bi-weekly coordination meetings between the SDC and the AGC commencing the first week after NTP for the SDC. The SDC should provide guidance to the AGC in terms of prioritizing items for which geotechnical recommendations are needed. The AGC will then provide preliminary and conservative recommendations for design, which should subsequently be confirmed, or made less conservative when the final borings are completed.

1.4.2 I-93 Mechanical/Electrical Systems Contract D020B

Contract D020B is the mechanical/electrical contract which encompasses all of I-93. It will be the responsibility of the D015A SDC to interface with the mechanical/electrical SDC for D020B.

The D020B SDC is responsible for final design of the mechanical electrical systems including:

- tunnel ventilation systems
- tunnel drainage system including low point pump station equipment
- roadway lighting systems
- tunnel lighting system
- power distribution system
- fire protection system

The related construction contract are C20B1 and C20B2.

1.4.3 Integrated Project Control System (D022A)

The Integrated Project Control System (IPCS) Section Design Consultant (D022A), will develop the IPCS final design.

Because of the IPCS projectwide integration effort, the D022A design contractor will interface with the great majority of the other CA/T Section Design Consultants (SDC's), including D015A.

The D015A SDC can expect to exchange design and equipment installation information with the D022A SDC. The information exchange will typically involve installation data for IPCS equipment located in Vent Building No. 4, Emergency Station No. 7, the underground cross-passages and utility rooms, along with TSCS signage, radio and communications equipment located along the D015A roadway section.

The IPCS equipment relating to the D015A section design includes:

- Traffic Surveillance and Control System (TSCS) - consisting of; signs, signals, vehicle detectors and CCTV.

- Facilities Control System (FCS) - including fire detection, intrusion detection, access control and interface with M&E ventilation, drainage and, power and lighting systems.

- Communications System - including phones, radio, fiber optics and Remote Terminal Units (RTU's).

1.4.4 Materials Disposal System

Excavated materials generated by the construction contracts will be beneficially reused where possible.

Reuse involves one of the following:

- Clean clay can be used for capping existing landfills.

- Granular historic fill can be processed where necessary and used as backfill on the CA/T Project.

- Non-granular historic fill can be processed and used as daily cover at landfills.

- Non-granular historic fill can be used for landfill closure and park preparation at Spectacle Island.

Interfaces with adjacent design and construction contracts are as presented in 1.4.4.1 and 1.4.4.2 below. A quantity, presently estimated at approximately 706,300 cubic yards, will be used for capping landfills. The material will be transported directly to the landfills by the construction contractors. There is no interface with other design or construction contracts in this case.

1.4.4.1 Materials Disposal System (Contract D021A)

A quantity, presently estimated at approximatly 313,000 cubic yards of excavated non-granular material will be disposed of at Spectacle Island. This material, which will be selected either by material type or by period of excavation, will be transported to the Barge Loading Facility at Dry Dock Number 3 in South Boston.

1.4.4.2 Materials Processing Plan (Contract D021B)

A quantity, presently estimated at approximately 28,000 cubic yards, of excavated granular material will be processed into backfill for reuse on the CA/T Project. This material, which will be selected by material type, will be transported to the South Boston Processing Area.

A quantity, presently estimated at approximately 320,000 cubic yards, of excavated no granular material will be processed into landfill daily cover. This material, which will be selected by material type or by period of excavation, will be transported to the South Boston Processing Area.

1.4.5 Right-of-Way Assessment and Remediation (Contract M025A)

The Right of Way Assessment and Remediation Services (ROWARS) Consultant, Contract M025A, will conduct environmental assessments of all parcels and buildings to be acquired to build and operate the project, characterize the nature and extent of any hazardous materials or hazardous release within the parcels and buildings and design any required remediation of the hazardous materials or release.

Remediation of sites will be carried out by either a separate remediation contractor prior to construction in that parcel or prior to demolition or use of a building, or plans and specifications will be provided to the SDC to incorporate into the 100% design package(s). Technical review and oversight of the remediation will be through the Management Consultant as assigned by the Department.

The ROWARS consultant will prepare the following documents:

Initial Assessment Report
Characterization Report
Clearance Plan (as needed)
PS&E for each area to be remediated (as needed)

Should the ROWARS consultant define nonhazardous conditions which require special handling for the purposes of materials disposal and/or protection of construction personnel, the ROWARS consultant will provide plans and/or specifications to be included in the SDC 100% design package(s).

It will be the responsibility of the D015A SDC to work with the ROWARS consultant to obtain all pertinent information for the D015A Contract Area.

1.4.6 Early Utility Relocations (Contract D014B & D014C)

Contract D014B utility relocations north to Causeway is the utility contract preceding D015A. It consists of two categories of relocations. Major utilities and minor utilities. These new permanent routes are designated as utility corridors. All transverse utility corridors shall cross the future tunnels at right angles to the fullest extent possible. Where feasible, longitudinal utility corridors are outside the future slurry walls for the cut-and-cover tunnel. However, some longitudinal relocations are located in the area directly above the future tunnels, and will require support during construction of the tunnel sections.

With the exception of gravity sewers and major utilities all others will generally be below existing lines.

In addition to the relocation of major utilities, there are several minor utilities which the D014B SDC must consider. These may include Western Union, fuel oil and brine in addition to roadway oriented facilities such as lighting, traffic signal, police signal, fire signal, drainage, and other facilities that may be in conflict with the construction of relocated major utilities. Design contract D014B will involve only relocations (temporary or permanent) of these facilities made necessary by the relocations of the major utilities.

The relocation design of minor utilities that may be in conflict with the construction of the cut-and-cover tunnel will be the responsibility of the D015A SDC.

Contract D014C utility relocations Congress to North is the adjoining utility contract south of the D015A contract area within the D017A Central Artery Congress to North. It has the same design considerations as D014B.

1.4.7 Final Surface Restoration D015C

Contract D015C is the Final Surface restoration contract associated with D015A. The final surface street alignment will be performed under D015A as well as interim planting. The D015C SDC will be responsible for the final surface preparation of roadways and sidewalks, as well as landscaped parcels.

It will be the responsibility of the D015A SDC to provide the D015C SDC with the necessary information relative to final alignment and site specific details upon completion of D015A.

1.4.8 I-93 North Area (Contract D019B)

Design Contract D019B, I-93 North Area, is the contract directly north of D015A. D019B and D015A share a contract limit at Station 168+50. D015A meet D019B slightly north of Causeway Street where the boat section meets existing grade.

The D019B contract serves to join the Central Artery with the CANA Project, thereby connecting Downtown Boston to Charlestown at City Square.

Similar to D017A, the interface with D019B is extremely important. The alignment of D015A is directly relative to D019B.

It will be the responsibility of the D015A SDC to work with the D019B consultant to coordinate and obtain all pertinent information for the D015A contract area.

1.4.9 Parcel 7 Parking - D016A

Contract D016A represents the first phase of the Parcel 7 Project, a multipurpose facility to be constructed on the Parcel 7 site (bounded by Congress, Sudbury, Blackstone and Hanover Streets), adjacent to the Central Artery in the Haymarket area of Downtown Boston.

The Parcel 7 Project is comprised of a number of ancillary transportation functions required to support the CA/T Project. Specifically, the Parcel 7 Project will include: a 350 space, structured parking garage; a ground level public marketplace; a tunnel ventilation building to service the Central Artery Tunnel from State to Causeway Streets; and additional commercial space located over the vent building. In addition, the project involves substantial reconstruction of the MBTA Haymarket Orange Line Station located at the site.

The Parcel 7 Project will be designed and constructed in phases to support overall CA/T scheduling needs. Section Design Contract (D016A) involves the first phase of the facility only. This initial phase includes the parking garage, associated ground floor marketplace building shell and the MBTA Haymarket Station alterations. The D016A SDC also will be responsible for completion of Schematic Design for the entire above-grade building envelope including exterior massing, architectural treatment, overall building circulation and support space requirements.

It is planned that the first phase of the Parcel 7 Project will function as an independent building until such time as the remaining building components (vent building, marketplace shell and commercial space) are constructed as part of the Central Artery Mainline Tunnel Contract. Final design of these remaining elements is included as part of the D015A SDC Contract.

1.4.10 I-93 Central Artery, North to Congress - D017A

Design Contract D017A is the highway tunnel contract directly to the south of D015A. These contracts share a contract limit at approximately station 141+00.

The interface between these two packages is extremely important. Much of what is designed under D015A will directly effect the D017A SDC. Horizontal and vertical design will need to be coordinated on a regular basis to insure a uniform design throughout the downtown section. Surface streets and ramps at the contract limits are directly related.

1.4.11 Joint Development/Air Rights

The City and State are currently engaged in a planning process for the future development of the parcels of land to be created over the Central Artery corridor from Summer to Causeway Streets. The City, through the Boston Redevelopment Authority

(BRA), has assumed the lead role in generating land-use options to be tested along the Central Artery corridor. The process includes the participation of a broad based group of community organizations and individuals. The State's role has been to participate in the public planning process and to generate technical studies and designs related to the tunnel structural envelope.

The State, in October 1990, completed a "Base Case" structural capacity study which analyzed on a parcel-by-parcel basis the ability of the tunnel structure, as it is currently designed, to support the air rights development (building or landscaping loads). Generic building grids and uniform landscape loads were tested.

A second phase technical study is currently underway in which the State is testing the actual air rights scenarios generated through the joint development planning process. This study is running parallel with the refinement of the Central Artery Tunnel Preliminary Design.

As part of this second phase effort, the State is comparing specific building envelopes and/or open space plans for each parcel against the base case loading capacity of the tunnel in the particular location. A determination is being made as to whether structural modifications are required in the tunnel, and if so, what cost premiums will be incurred. Evaluation of possible alterations to the tunnel ventilation systems and other specifics of tunnel design are also being done on a parcel-by-parcel basis. This work is essential for informing participants in air rights planning to make recommendations about whether and where to add structural capacity to the tunnel. The schedule calls for completing the analyses of all building parcels by March 1991.

Following completion of this study, the State, City and FHWA will reach a consensus on which sections of the Central Artery Tunnel are to be designed to carry specific air rights loads. These design loads will then be transmitted to the Section Design Consultants for incorporation into the final design of the respective tunnel segments. It is anticipated that these loads, when available, will be provided to the SDC.

The SDC should also anticipate that they may be requested to generate cost information related to any premiums associated with reinforcing the tunnel box to carry potential air rights loads.

1.5 Project Design Criteria

The purpose of the Project Design Criteria is to establish uniform design criteria for the Central Artery (I-93)/Tunnel (I-90) project. The criteria are intended for use by all parties involved in the product design, referred to as designees, including the personnel of the Management Consultant

performing the preliminary design and the Section Design Consultants and their subconsultants performing the final design.

The Project Design Criteria will be provided to the SDC at the time of Notice to Proceed (NTP). The SDC shall adhere and conform to the criteria as discussed in the following sections.

Organization and Contents

These criteria consist of nine sections, numbered I through IX.

Following is a listing of the sections and a summary of their contents:

Section I - Introduction

Purpose and general organization of the criteria.

Section II - Basic Policies

Basic policies governing the use of criteria.

Section III - Civil

Design criteria for geometric controls, clearance requirements, drainage, and other elements of design for highways and city streets.

Section IV - Utilities

Design criteria for the relocation, support or maintenance of existing utilities that will be affected by the project construction and for the installation of new utilities.

Section V - Structural

Design criteria for structures, including bridges, retaining walls, cut-and-cover structures, immersed tubes, above-ground structures, temporary construction structures and other miscellaneous structures.

Section VI - Architectural

Design criteria for the architectural treatment of bridges, tunnels, transition sections, at-grade roadways, toll plaza, ancillary buildings and noise barriers, and for landscaping.

Section VII - Mechanical

Design criteria for mechanical systems, including the tunnel ventilation, tunnel drainage, plumbing, fire protection, and ancillary facilities heating, ventilating and air-conditioning systems.

Section VIII - Electrical

Design criteria for electrical systems, including the primary distribution, secondary distribution, standby power, grounding and lighting protection, building lighting, tunnel lighting, exterior roadway lighting, tunnel raceway and underground raceway systems.

Section IX - Traffic Surveillance and Control

Design criteria for signage and for the traffic surveillance and control system.

2.0 Survey

The project mapping was prepared from aerial photography flown on August 2, 1987. The photographs were taken at an altitude to support 1 inch equal 20 feet (20 scale) mapping. Primary control was installed by the Global Positioning System (GPS) on an XYZ rectangular coordinate system and is a first order-class 1 survey.

Applicable survey information for the D015A contract is shown on the survey control sheets which is made part of the preliminary design package.

3.0 Geotechnical

3.1 Existing Data and Planned Explorations

As shown on Drawing No. PW-PD-K-075, Boring Location Plan, there are a considerable number of previously drilled borings in the Central Artery corridor.

Subsurface profiles along the proposed slurry walls are shown on Drawing Nos. PW-PD-K-076 and PW-PD-K-077. Most of the borings shown on the Boring Location Plan were drilled as part of the exploratory program for the original Central Artery construction. A few are from more recent explorations perfomed under the technical supervision of Bechtel/Parsons Brinckerhoff. Boring logs showing the existing data are compiled in "Geotechnical Report, existing Subsurface Data, Central Artery - South of Causeway", the companion volume for "North of Causeway," and in "Geotechnical Data Report, Pilot Boring Program and in the Geotechnical Report Subsurface Exploration and Laboratory Testing, Parcel 7 Facility - Phase A." A copy of the logs of borings shown on the Dwg. No. PW-PD-K-075, boring location plan, is presented in Appendix C of the Preliminary Design Report. Copies of these documents will be available to the SDC for information.

It is difficult to ascertain the relative accuracy and reliability of the various sources of the existing data. Therefore, the soil profiles shown in the preliminary design drawings may not accurately represent actual soil conditions at all locations, and particularly at locations where the data are interpolated between borings.

In general, it is concluded that sufficient geotechnical information exists for the purposes of preliminary design. There are Standard Penetration Test (SPT) data in all strata, which allows preliminary analysis of the various subsurface soils with regard to stiffness or density, bearing characteristics, and expected vertical and lateral earth pressures.

An extensive program of exploratory borings and test pits will be conducted within the next few months by the Area Geotechnical Consultant (AGC). Approximately 70 borings will be performed along the Project Alignment. Borings will be performed specifically related the D015A Design Contract. Additional borings along the alignment will also be performed for the utility relocations which are part of the D014B Design Contract.

3.2 General Subsurface Conditions

The subsurface conditions along the Project location, as shown in Drawing Nos. PW-PD-K-076 and PW-PD-K-077, are highly variable. In general, the subsurface profile consists of the following strata:

Fill - consisting primarily of sand and gravel, but also containing zones of more clayey or silty material, and cobbles, brick, concrete and other miscellaneous materials. The fill stratum is usually found directly below the pavement or concrete areas, and extends to a depth of 10 to 20 feet below the ground surface.

Organic Silt - consisting primarily of soft silt and shells. The organic silt stratum is present between Northbound (NB) Station 155 +/- and 169 +/-. Where it exists, the organic silt is found directly below the fill stratum.

The thickness of the organic silt stratum is usually 5 to 20 feet with generally greater thicknesses occurring towards the north of the Project location within the D015A contract limits.

Silt Clay - The silty clay stratum is usually stiff to hard near the top of the stratum, but becomes medium stiff to soft with depth. In areas where there is an organic silt stratum, the silty clay underlies the organic silt. Where the organic silt stratum is absent, the silty clay stratum directly underlines the fill. The silty clay stratum has thicknesses up to 90 feet, which occurs towards the southern end of the contract limits. (NB Station 140 +/- to 145 +/-).

Glacio-marine Deposit - From NB Station 145 +/- to 153 +/-, neither the silty clay nor the organic silt is present. Instead, directly underneath the fill is a glacio-marine deposit, consisting of a mixture of silty clay, sand, gravel, and cobbles. The glalcio-marine deposit is relatively stiff or dense.

Silty Fine Sand - This stratum exists from NB Station 160 +/- to 164 +/-. It is found beneath the organic silt stratum, and is loose to medium dense. The greatest thickness of this stratum, which is about 20 feet, occurs near Station 164.

Glacial Till - consisting of a mixture of sand, gravel, silt, and clay, this stratum exists immediately above the bedrock at practically all locations. The thickness of this stratum is usually 2 to 10 feet. The top of the stratum usually occurs at a depth of 60 to 110 feet.

Bedrock - consisting of the Cambridge Argillite. The top of rock occurs typically at depths of 70 to greater than 110 feet. The rock is variably weathered and fractured.

Groundwater is usually encountered within the fill at depths of 5 to 15 feet below the ground surface. However, there is evidence that groundwater wells installed with screens in the till or rock may indicate readings below the hydrostatic levels encountered in the fill.

3.3 Geotechnical Design Elements

The proposed tunnel structures and boat sections, which are part of the D015A Design Contract, consist of reinforced concrete sections that will be constructed using the cut and cover method. To perform the excavations, it is anticipated that the temporary excavation support will consist of concrete diaphragm walls constructed by the slurry trench method or by the soldier pile tremie concrete (SPTC) method. The temporary excavation support walls are intended to eventually be structurally integrated into the walls of the permanent structure.

The design of the excavation support and permanent structural walls of the tunnel will require consideration of lateral earth pressures, pore water pressures, and other lateral loads due to traffic, construction equipment, and earthquake. The walls will have to be designed to support vertical loads due to the weight of the permanent tunnel structure and backfill on top of the tunnel. In most sections, there will also be vertical loads due to the street level traffic decking and underpinning of the existing overhead Central Artery structure. The street level decking and underpinning of the existing structure are required to maintain traffic flow during construction.

Another geotechnical design consideration is the need to resist uplift forces due to hydrostatic water pressures acting on the bottom slab of the tunnels. These uplift pressures will be especially problematic at boat sections and in the relatively deep structure at Vent Building 4. At these locations, considerations for resisting the uplift load may require the design of either a gravity slab, concrete hold down elements, or tie-down anchors.

The protection of adjacent buildings during construction is an important design consideration. The diaphragm walls should be designed to provide adequate stiffness to limit deformations of adjacent structures. In some cases, it may be necessary to underpin existing buildings to prevent potential damage that may otherwise result during excavation.

During construction, it will be necessary to dewater the excavation, and at the same time, to maintain the existing ground water levels outside the excavation. The requirement for maintaining existing ground water conditions is related to the protection of old buildings founded on wooden piles, which may deteriorate due to exposure to air resulting from ground water lowering. The design of the excavation should also consider problems of bottom stability that may result from dewatering.

There are several interfaces with other design contracts which should be considered. These include the Parcel 7 parking and market facility which is adjacent to Vent Building 4. In addition, there are several design interfaces with the D014B Utilities Relocation Design Contract. At these interfaces, the

concrete diaphragm walls related to these other design contracts will be constructed before the walls for the D015A Design Contract. In addition, it is important to consider the sequence of construction within the D015A Design Contract and the limitations imposed by the sequence on the design of the structures.

Geotechnical recommendations for the final design of the tunnel structures, boat sections, and Vent Building 4, will be provided by GEI Consultants, the Area Geotechnical Consultant primarily responsible for the D015A Design Section. However, for the small portion of the alignment north of Causeway Street, Stone & Webster Engineering Corporation will provide the final design recommendations.

4.0 CIVIL DESIGN

4.1 General

The purpose of the Civil Design Section is to describe the factors which governed the civil design of D015A. Contract D015A meets contract D017A approximately at the portal of ramp CS-SA at Station 141+00 just south of the Callahan Tunnel, and meets contract D019B north of the portal at Causeway Street, Station 168+50. It includes CS-CT and SA-CT ramp connections to the Callahan Tunnel, ST-CN and ST-SA ramps from the Sumner Tunnel, as well as the surface street ramps CS-SA and SA-CS. Ramp CN-SA, although a D017A ramp, will require surface street alignment under D015A. The D015A contract also includes the surface street system within contract limits, four temporary ramps, pump stations (to drain water from the portals), emergency egress stairwells, emergency station #7 and other incidentals necessary for the completion of the contract. The alignment is controlled by several constraints described in this section.

4.2 Project Datum

Horizontal control for roadway alignments is based on survey control points established and referenced to the Massachusetts State Plane Coordinate System, Mainline Zone, and North American Datum, 1983 (NAD 83). Vertical control is based on the National Geodetic Vertical Datum of 1929 (NGVD 1929), formerly US Coast and Geodetic Survey Mean Sea Level Datum of 1929. The project datum plane is established at 100.00 feet below NGVD 1929.

4.3 Design Description

The following section will discuss aligning the Central Artery through the Downtown Boston Corridor. The necessity of existing structures to remain and the close proximity of their foundations imposed numerous design constraints. In all possible cases, the project design criteria was met. In other cases, a balance of design considerations was attempted in order to rationally apportion deviations and exceptions. The project Design Criteria cites AASHTO and MDPW standards, and this report cites the design considerations encountered while attempting to adhere to those standards.

In the northern portion of the D015A Alignment, I-93 profile grade is steep in order to clear the Charles River and get beneath Causeway Street. The highway continues to descend at a lesser grade beneath two (2) 48-inch gravity flow combined sewers as it heads south to accommodate the ramps (and the required structural depths and vent thicknesses) passing overhead at the Sumner/Callahan tunnel area. The D015A alignment meets the D017A contract as the alignment begins to climb in order to cross above the MBTA Blue Line.

Due to the fact that many of the walls (as well as roof/floor slabs) between the ramps and main lanes are "common" (shared by both) many of the constraints have a ripple effect through out the alignment. The Purity Cheese building and Stillman Apartments dictate the layout of Ramp ST-CN which directly effects I-93 NB & SB. The existing Orange Line on the west controls I-93 SB which shares a common wall with I-93 NB and influences where CS-SA exits the mainlane. The Dock Square Garage is also a factor as ramp CS-SA is constrained to the west at this location.

The loop ramps crossing the main lanes (SA-CT, CS-CT) going into the Callahan tunnel sit on top of the I-93 tunnel boxes. They share common roof/floor slabs with the northbound and southbound main lanes (the vents on the ramps have been rolled to the sides to allow for more clearance).

Ramp SA-CS descends from the surface to get beneath CS-CT and CS-SA. This ramp shares a common wall with Ramp SA-CT for approximately three hundred feet from the portal. At this point, it has descended enough to join the I-93 SB wall before it merges with the main lane. The geometry of these ramps and the main lanes are related based on their common walls. There is a similar relationship with ST-SA, I-93 NB, and ST-CN.

4.3.1 Transition Curves, Superelevation and Cross Slope

The primary purpose of transition curves is to ease the driver into relatively sharp central curves, providing an alignment that allows most drivers to negotiate the tangent to curve shift without straying out of their lane while maintaining even speed. A spiral curve is geometrically the most efficient way to effect this transition. However, to avoid field layout problems associated with congested urban areas, a series of compound circular curves are used as a simulation. The introduction of compound curves to supplant a spiral requires the superelevation transition to be apportioned along the tangent and first curve(s), so that full superelevation is accomplished at the central curve.

Transition curves also provide a convenient place to runoff superelevations. CANB has two transition curves of 4250 feet radius (4200 feet CASB) on either side of a 2250 feet radius central curve (2385 feet CASB). The 200 feet lengths allow transitional from a normal cross slope of 2% through 2.5% (4250' radius), to the required 4% (2250' radius). This transition begins in Design Section D017A, where a 6% cross slope is required in the opposite direction. At the interface with Section D019B, the straight cross slope transitions to a crowned cross section, this 7600' radius requires no superelevation.

The Central Artery ramps transition from 2% cross slope at the mainline to a maximum of 6% where the radii dictates. Due to the location of existing structures to remain and the lower design speed of the ramps, transition curves have not been used for all cases.

4.3.2 Sight Shelves

Horizontal stopping sight distance is limited by right-of-way constraints that require small radius curves as well as limit the distance the walls can be pushed back from the travelled way to provide clear sight lines. Any object higher than 8 to 9-inches encroaches on the sight line from the driver to a 6-inch object in the center of the lane. Sight distance, then, is measured to the face of the safety walk, not to the face of the wall.

The areas of curves where the radii are short require widening the pavement on the inside edge to allow for adequate horizontal sight distance. This widened pavement is called a sight shelf, and its design is based on the radius and speed or sight distance.

The required minimum width of the sight shelf is given by the formula $M = R[1-\cos(28.65s/R)]$, or 5.8 feet for the 2250' radius 50 miles per hour mainline curve (R = 2207', s = 475'). m = 12.8'; therefore, the sight shelf equals 12.8' less 6' half lane width, less 1' shoulder = 5.8'. (Using a sight distance of 400', the required sight shelf drops to 2.1'.) The 4200' radius curve needs no sight shelf.

Ramp sight shelf requirements vary from 0 to 7.1' in width, as follows. The mainline off ramp, CS-CT/SA, requires a 2.4' minimum to 6.1' desirable wide shelf. None is provided, however, due to the close proximity of the MBTA Orange Line Structure. Further along its alignment it requires a 1.2' shelf on the other side. Ramp CS-SA requires a 2.1' shelf on one side followed by a 0.7' shelf on the other. However, a sight shelf has not been provided due to the close proximity of the Dock Square Garage. The ramps to and from the Callahan and Sumner Tunnels require sight shelves on the order of 6.1 to 7.1 feet.

4.3.3 Entrance and Exit Gores

The standard entrance and exit ramp details allow smooth transition from a ramp onto the mainline and vice versa. Detail sheet No. CA-PD-C-363 provides the length of taper necessary to properly merge a ramp with the Central Artery mainlines based on the width of the nose. The details also allow a safe refuge and decision area at exit ramps, while also providing room for an impact attenuator.

Ramp ST-CN has a narrow entrance ramp, the 20' travel lane at the nose of CANB Station 154+00 tapers to a 14' lane in 200 feet, instead of the required 233 feet [(2'2" + 4'0" + 3'2") x 25 = 233'4"]. Ramps SA-CS tapers from the nose at Station 141+25 to 12' in 200'. These reductions in taper length are the result of concerns for right of way and geometry.

Exit ramp CS-SA/CT has more than adequate offset at the gore. Twelve feet are required from the lane edge to the extended edge of the safety walk, and 16 feet are provided. This may easily be refined during final design.

The remaining entrance and exit ramps are low speed loop ramps to and from the Callahan and Sumner tunnels and the Surface Artery. The close proximity of the existing structure govern the geometry rather than the design criteria.

4.3.4 Vertical Alignment and Clearance

To lessen the grade of I-93 and conform to project criteria, Causeway Street has been raised as much as is practicable to maintain driveways and sills of existing buildings on the street. Mainline clearance is reduced to 14-feet 6-inches, structure depth is reduced to 4-feet and vents are eliminated. This results in careful sign design and placement at ramps.

Elsewhere throughout the alignment, ramp and mainline structures share roof slabs, floor slabs and walls. Vents are in the ceiling and floor for the most part. Any design modifications invariably effect the horizontal and vertical alignment. Also, with few exceptions, ramp grades reach the maximum allowable of 7%.

4.4 Construction Staging and Traffic Management

The maintenance of safe, efficient vehicular and pedestrian traffic flows during construction is a sensitive issue which must be coordinated between all interfacing construction contracts. In creating maintenance of traffic plans, consideration must be given to all of the contractors, subcontractors and public agencies involved as well as providing for pedestrian access to adjacent properties.

The method of wall construction selected for the majority of the tunnel construction is slurry walls using soldier piles and tremie concrete (SPTC walls). some sections will allow the use of steel sheet piling, however, this will generally only occur where the tunnel lies close to the surface or the proposed structure is a boat section or depressed roadway. Slurry wall (SPTC) construction will be accomplished in varying length sections of up to 20 feet long, alternating along each side of the alignment. Early emphasis will be placed on construction of the east side slurry wall (SPTC) to provide for the construction of the CANB tunnel and northbound ramps. Following construction of the slurry wall (SPTC), intermediate supports (drilled caissons) will be installed thus providing support for the deck beams and decking which span between the slurry walls (SPTC) and drilled caissons. Upon completion of the decking operation, the contractor will begin excavation, intermediate cross bracing installation and tunnel construction.

Also included as part of these traffic management plans are the removal of five existing ramps and the construction of four temporary ramps which service the existing Central Artery viaduct. The staging of the existing ramp removal and subsequent temporary ramp installations will be a crucial part of the traffic management plans. The final design should include a detailed construction staging plan which ensures both vehicular and pedestrian traffic flows to active uses adjacent to the alignment.

4.5 Design Exceptions

The D015A contract area through downtown Boston is an extremely congested section of the city. The sensitivity of the area along with the close proximity of existing structures has resulted in necessary design exceptions. These existing conditions have created an extremely narrow corridor for design. This section will outline exceptions specific to the D015A area.

Formal design exceptions have been requested for the following roadway features described herein:

	Roadway Feature	Exception Requested From
1.	Shoulder width	Project Criteria
2.	Stopping Sight Distance	Project Criteria, FHWA
3.	Transition Curves	Project Criteria

1. Shoulder Width

Project Criteria, Article 4.2: Mainlanes: 4' left, 10' right
Multilane Ramps: 4' left, 8' right

1984 AASHTO, Chapter 4, p. 425: Desirable: 5' left, 10' right
Minimum: 1' left, 1' right

Proposed Action: All mainlanes and ramps: 1' left, 1' right

Discussion:

Shoulders, particularly in a tunnel, serve two functions:

a. Safe refuge for disabled vehicles
b. Additional lateral clearance to lessen the feeling of confinement.

Severe right-of-way restrictions require that the tunnel cross section be kept to an absolute minimum width. Even with the shoulders reduced to (1) foot on each side, the tunnel is a tight fit.

Included in the project are several design features intended to offset or minimize the impact of narrow shoulders:

a. A state-of-the-art emergency response control network is being designed to provide rapid response to any incident in the tunnel. The system will include closed circuit TV monitoring, variable message signs and tunnel radio advisories along with many other features. The proposed system is detailed in the Traffic Surveillance and Control System Concept Report.

In addition to these electronic surveillance methods of controlling operations, some refuge occurs at intermittent locations throughout the alignment:

- At all exit ramps a recovery gore is provided that can also provide refuge in an emergency.
- On all curves a sight shelf is provided on the inside of the curve that can provide refuge in an emergency.
- At intermittent locations "extra" space is available as a result of adjacent tunnel boxes not running parallel.
- The feeling of confinement in the tunnel is being addressed by the architects and lighting engineers.
- Highly reflective surfaces are being studied for walls and ceilings.
- Tile patterns that help orient the driver and provide continuity as well as information are being developed.
- Lighting will be designed to transfer the driver from daylight to tunnel and back through a series of zones that will prevent temporary blinding from sudden light or dark.

These designs are described in the Tunnel Finishes Concept Report, the Tunnel Lighting Concept Report and The Highway Architecture.

2. Stopping Sight Distance

	Mainlanes	Min.	Desirable
Project Criteria Table III-2-5:	50 M.P.H.	400'	475'
1984 AASHTO: TAble III-1:	45 M.P.H.	325'	400'
	Ramps		
	40 M.P.H.	275'	325'
	30 M.P.H.	200'	200'
	25 M.P.H.	150'	150'

Discussion

Horizontal Stopping Sight Distance is limited by right-of-way constrints that require small radius curves as well as limit the distance the walls can be pushed back from the travelled way to provide clear sight lines. Any object higher than 8 to 9-inches encroaches on the sight line from the driver to a 6-inch object in the center of the lane. Sight Distance, then, is measured to the face of the safety walk, not to the face of the wall.

All ramps have horizontal Stopping Sight Distances sufficient for at least 40 M.P.H. elsewhere except the Calahan and Sumner Tunnel ramps. The horizontal Stopping Sight Distance on those ramps is for 25 M.P.H. because of the restrictions caused by adjacent buildings. (Note that most ramps have 25 M.P.H. vertical curves as they meet or leave the surface streets and have been designed as loop ramps according to Project Standards.)

Stopping distance is based on two components: Brake reaction time and braking distance. Brake reaction time, the time required to see an obstruction and decide to stop, varies widely by driver and roadway conditions. The values used in design tables assume an unexpected incident (i.e., a "non-alert" driver) and a slow reaction time (based upon laboratory measurements or reaction time). It can be expected that drivers in the Central Artery tunnel will be alert because of the tunnel environment, the urban surroundings and the heavy traffic volume.

Of greater importance in the tunnel, however, is the second component of stopping distance. Braking distance on the level is calculated by the formula: $d = V2/30f$ (AASHTO, p. 139)

where d = braking distance, ft.
v = initial speed, M.P.H.
f = coefficient of friction between dires and roadways

Design values presented by AASHTO for stopping sight distance (Table III-1, 1984 AASHTO, p. 138) are based on wet pavement friction coefficients according to Figure III-1, (1984 ASSHTO, p. 141) dry pavement, which is the usual case in a tunnel, has a friction coefficient approximately twice as large as wet pavement. For example, on level, dry pavement, the braking distance from 45 M.P.H. to stop is 104 feet using f = 0.62. On wet pavement, braking distance for 45 M.P.H. is 218 feet using f = 0.31 no adjustment of design value is warranted, but a much higher friction factor can be expected in a dry tunnel than on air open roadway.

Braking distance and, therefore, stopping sight distance must be adjusted for grade. Braking distance increases on a down grade, decreases on an upgrade. A grade of 3% or more is considered significant. The braking distance formula is

adjusted to $d = V^2/30 (f = +/- g)$ where g = decimal value of grade (AASHTO p. 143). Using the same 45 M.P.H. example as above, with a 5 % grade:

5% downgrade: Wet pavement f = 0.31 d = 260 ft
Dry pavement f = 0.65 d = 113 ft

5% upgrade: Wet pavement f = 0.31 d = 188 ft
Dry pavement f = 0.65 d = 96 ft

AASHTO Table III-2 provides stopping distance corrections for use in design based on wet pavements.

Design speed for these ramps is 80% of mainlane speed for 40 M.P.H., requiring stopping sight distance of 275-325 feet. By AASHTO Table III-2 (interpolating), a 7% downgrade at 40 M.P.H. on wet pavement required an additional 50 feet sight distance.

3. Transition Curves

Project Criteria, Figure III-3-2: requires that any curve with R </- 3,300 feet must be transitioned with compound curves in succession at Rn+1 = 1.5 Rn.

1984 AASHTO, No specific criteria are provided.

Discussion

Right-of-way constraints limit the space available for transition curves while requiring small radius curves.

The primary pupose of transition curves is to ease the driver into relatively sharp central curves, providing an alignment that allows most drivers to negotiate the tangent to curve shift without straying out of their lane while maintaining even speed.

Transitional curves also provide a convenient place to runoff superelevation. Calculations show that 300 feet is a reasonable distance to runoff the superelevation for the sharpest curves on this alignment.

5.0 Structural Design

This chapter includes four sections:

- 5.1 Tunnel Design
- 5.2 Boat Section Design
- 5.3 Design of Vent Building 3/4
- 5.4 Design of Artery Viaduct Underpinning

5.1 Tunnel Design

Plan, layout, sections and profiles of Central Artery tunnels are shown in various documents which comprise the preliminary design package.

In this section, elements of the tunnel design are reviewed.

5.1.1 Tunnel Design- General

Central Artery tunnels will feature the following type of construction:

- Tunnels will be built by the cut-and-cover method.
- To support the excavation, three rigid cofferdam walls will be built, except north of Station 151 +, where a cast-in-place center wall will be constructed.
- Cofferdam walls will be integrated in the final structure.
- Cofferdam walls will be largely of soldier pile tremie concrete (SPTC) construction.
- Mainline roof members will be largely of steel beam and concrete slab composite construction.
- Base slabs will be constructed of reinforced concrete.
- Interior ramp walls and some roof members will be constructed of cast-in-place concrete.

Design loadings, load combinations, code specifications, and other criteria are discussed in the Project Structural Design Criteria.

5.1.2 Soldier Pile Tremie Concrete (SPTC) Walls

Cofferdam walls will feature soldier pile tremie concrete construction. The soldier piles will be spaced from 4' to 6' on center, with wider spacing in special locations determined by final design.

5.1.3 Roof Slabs

Roof slabs will be built using steel girder concrete composite construction. The steel girders will be spaced to match the layout of the soldier piles in the slurry walls. The concrete roof slab will be compositely connected to the girders by shear studs. The roof girders will be rolled sections or built-up girders depending on the final design. Preliminary design of the roof girders assumes a pinned connection to both SPTC walls and cast-in-place walls. The final design may find some advantage in detailing fixed connections at some locations. Where permitted by the vertical layout, the final design should consider some roof beams to run continuously across cast-in-place walls.

5.1.4 Base Slabs

Base slabs will feature cast-in-place construction. Preliminary design layout has used, for analysis, only the portion of the base slab below supply vents. The final design should consider the advantages of a Vierendeel framing model, or another appropriate model, to take advantage of structural action of the roadway slab.

Preliminary design treats the connection of base slabs to walls as fixed. One possible detail to achieve this connection requirement is shown in the preliminary design drawings, SDDS Tunnel.

5.1.5 other Structural Elements

a. Excavation Support

Excavation support is envisioned to be cross-lot bracing. Pin piles may be required between cofferdam walls for wider cuts. The design may be able to take advantage of tie-backs in some areas.

b. Interface With Underpinning Support

Refer to Section 5.4 of this chapter for additional information about design of underpinning for the existing Central Artery viaduct bents. Note that the underpinning will be largely supported by cofferdam walls. The final design will include details to ensure that underpinning loads are transferred adequately in the longitudinal direction so that cofferdam wall base bearing pressures will be acceptable.

c. Tunnel Cross Passages and Utility Rooms

Preliminary design includes layout of cross passages spaced at approximately every 300' along the alignment. Some of the cross passages and emergency egress/access passages include small tunnels, which will be built of reinforced concrete.

Cross passages are placed between soldier piles where they penetrate cofferdam walls.

Pump Stations are located as indicated in the preliminary design documents.

d. Interface with Vent Building 4

Lateral vents connect the mainline and ramp tunnels centered at approximately Station 148 Northbound. The final design of the structural sections at this location will need to take into account the position of these vents and the changing support and framing conditions that they impose on the tunnel boxes.

e. Waterproofing

Waterproofing concepts are reviewed in a separate report. Waterproofing is of additional concern for Central Artery tunnels because the cofferdam walls are integrated with the final structure. The final design must provide for watertightness at the connections of the roof to cofferdam walls, and base slab to cofferdam walls.

5.2 Boat Section Design

Two types of boat (transition) sections are included in design contract D015A: ramp boat sections and mainline tunnel boat sections

5.2.1 Ramp Boat Sections

Exit and entrance ramp boat sections are mostly part of the overall tunnel frame structure. They are positioned alongside or above mainline tunnel boxes. They should be designed as part of the overall tunnel framing structure.

5.2.2 Mainline Boat Section

A short boat section is found at the transition from tunnel to bridge structure north of the Causeway Street portal. This mainline boat section extends from about Station 164 Northbound to Station 168+50 Northbound. Preliminary design of the section assumes use of gravity slabs for purpose of stability against buoyant uplift. The design does not preclude use of tie-downs or anchor piles in this area.

5.3 Design of Vent Building 4

This section describes the structural type selected for ventilation Building No. 4, which is part of Design Contract D015A.

5.3.1 Design of Vent Building 4- General

An analysis was made of the building configuration which was presented for the "Proposed Action " alignment. Based on this configuration, the depth of the building (approximately 110 feet under grade level) became one of the principle design issues due to hydrostatic uplift pressure, the water table being at just 6 feet to 8 feet below grade level.

This became the basis for selecting the most satisfactory method to provide the building stability against hydrostatic uplift forces. Three methods were investigated:

- By gravity.
- By pumping water at lowest level.
- By using tie-downs.

Based on the building configuration and structural/architectural requirements (especially the need to integrate the ground floor and subgrade 1 levels, where the market area and the market support area are one open space with the D016A building areas) column grid lines were established. This became the basis for selecting a typical structural framing bay for which several alternative structural systems were designed for the above mentioned methods, where applicable. Two reinforced concrete alternatives were designed for the substructure while five alternatives (three in structural steel and two in reinforced concrete) were designed for the superstructure.

The comparative technical/cost analysis for the building primary structural components results in the following recommendations for structural components of Vent Building #4:

- Building Foundation: Reinforced concrete mat foundation with tie-downs as required.

- Building Substructure Perimeter Walls: Reinforced concrete or soldier pile tremie concrete slurry walls (pending on what the tunnel walls are going to be) structurally integrated with other building substructure components as part of the permanent structure.

- Building Substructure Floor Slabs: 15" thick (±) reinforced concrete slab supported by concrete beams and girders (Alternative I).

- Building Superstructure: 2 1/2" concrete topping on 3" metal deck supported by steel beams and girders.

- Exhaust Stacks: Reinforced concrete walls structurally integrated with other building superstructure components.

5.4 Design of Artery Viaduct Underpinning

This section describes the Underpinning of the elevated structure during the construction of the subsurface Artery Viaduct which is part of Design contracts D015A, D017A, D017B, D017D, and D019B.

5.4.1 Scope

Traffic will be maintained on the existing elevated Artery Viaduct between Bent 1 and 67 during construction of the new subsurface Artery. Traffic will then be diverted to the new subsurface Artery prior to the demolition of the elevated structure. In order to construct the subsurface Artery which is below the existing elevated structure, it will be necessary to underpin the elevated roadway.

5.4.2 Method

In general, the Underpinning system will consist of needle beams bracketed to the existing elevated structure columns which in turn will be supported on grade beams. The grade beams will generally be installed just below grade to allow for the installation of a decking system and in turn supported on either slurry walls or drilled caissons at both ends. Special consideration will be given to surface traffic, construction of entrance and exit ramps for traffic staging and the support of Major Utility Banks.

5.4.3 Suggested Construction Procedure

a) Install slurry wall or drilled in caisson.

b) Excavate and install grade beams supported on slurry walls or caissons.

c) Install needle beams on grade beams and bracket to existing elevated structure columns. Each bent to be designed to allow for maintenance of surface traffic and staging for new construction.

d) Transfer dead load of elevated structure to underpinning system, by jacking or other approved method.

e) Excavate for new subsurface Tunnel Structure removing existing footings and piles of elevated structure.

f) Construct subsurface tunnel.

g) Transfer traffic from elevated viaduct to subsurface viaduct.

h) Demolish existing elevated structure.

i) Remove underpinning system and decking.

5.4.4 Materials

a) Brackets - Steel plates and bolts

b) Needle Beams - Rolled Steel Sections

c) Grade Beams - Rolled Steel Sections or Built up plate Girders

d) Caisson - 36" diameter, drilled, reinforced concrete, belled.

5.4.5 Bearing On Slurry Wall

As indicated in Section 5.4.2, the grade beams supporting viaduct underpinning will bear on either slurry walls or caissons. For the case of bearing on slurry wall, the final design must ensure that underpinning loads are distributed adequately in the longitudinal direction of the tunnel, such that the Soldier Pile Tremie Concrete (SPTC) slurry wall is not overstressed and that bearing pressure on the till is within allowable limits. Of particular concern is the tributary area of wall which carries the underpinning load. The final design will include analysis methods and appropriate details to meet these design requirements.

5.5 Summary

The site location of Emergency Station No. 7 is at the intersection of New Chardon Street and the Surface Artery southbound in downtown Boston.

An evaluation was made of the building function and configuration for the purposes of recommending a structural system. Of special note is the building location which is founded directly over the future MBTA Green Line tunnel box (by others).

Consequently, the recommended foundation system for Emergency Station No. 7 consists of reinforced concrete grade beams on 3 ft. diameter caissons, bridging over the MBTA Green Line roof slab, with an 8-inch thick reinforced concrete grade slab.

Column grid lines were established based on the overall Operations and Maintenance functional requirements. This became the basis for selecting a typical structural framing bay for which alternative structural systems were designed for the superstructure floor slabs.

The comparative technical/cost analysis for the facility primary structural components resulted in the following recommendations:

- Foundation/Substructure:
- 3 ft. diameter caissons, located on each side of the MBTA Green Line.

- Reinforced concrete grade beams, bridging over the MBTA Green Line roof slab.

- 8-inch thick reinforced concrete grade slab.

- Superstructure:
- A 2 1/2-inch concrete topping on a 3-inch metal deck supported by a structural steel framing system. The steel framing consists of steel girders, beams and columns with the girders spanning in the short direction.

6.0 D015A Preliminary Design Report Mitigation

6.1 Introduction

Mitigation is an integral part of the design and construction process for the CA/T Project. The overall goal of the mitigation program is to minimize the disruptive effects of construction while maintaining the schedule, quality, and cost effectiveness of the project.

This section is intended to provide the SDC with information as well as guidelines and requirements to aid in the development of mitigation plans and specifications. It contains 1.) a description of existing conditions in the project area, highlighting those that are particularly sensitive to mitigation issues, and 2.) specific areas within the contract boundaries which must be addressed with mitigation strategies.

The SDC shall work with CA/T mitigation staff throughout the final design process to ensure effective mitigation measures are integrated into the final design. Mitigation reviews will be conducted throughout the design and construction process.

6.2 Existing conditions

6.2.1 General Description (see map at end of this section)

The area bordering Contract D015A consists of several sub-areas. To the north-east is the North End which is comprised of both residential and commercial/small business uses. To the south-west are the Bulfinch Triangle and the Blackstone Block/Haymarket, which is an historic, commercial, and tourist area. Also on the south-west side are the Government Center Garage and the Haymarket MBTA Station. Government Center and Quincy Market lie just at the periphery of D015A.

1. Blackstone Block/Haymarket

- The Blackstone Block, bounded by Blackstone, North, Union and Hanover Streets, contains most of Boston's few remaining Colonial period buildings and streets, and is listed on the National Register of Historic Places.

- The area is almost exclusively commercial with several restaurants, a hotel, and retail businesses as well as Boston's only year-round, open-air produce and food market, known as Haymarket.

- Haymarket operates on Fridays and Saturdays from about 7:00 am to 7:00 pm. The installation of vendor stalls begins Thursday evening. Vendors park their trucks on Blackstone Street and unload goods throughout the next day.

- Blackstone Street is heavily traveled both 1) on Fridays and Saturdays due to Haymarket operations, and 2) year round as it is a major route between Government Center and I-93 southbound.

- The Freedom Trail passes through the Blackstone Block on its way to the North End.

- Blackstone Street is used as a pedestrian through fare from the Haymarket MBTA Station to Fanueil Hall and beyond.

2. Government Center Garage and MBTA Haymarket Station

- The Government Center Garage has a capacity for 1,865 vehicles in a 7-story structure.

- Currently, two additional floors are being added to the garage structure (due to be completed by the end of 1990) to house 250,000 square feet of office space. On the street level, retail space is being developed adjacent to the Haymarket MBTA Station.

- The subway station is serviced by the Orange and Green Lines augmented by several bus lines.

3. Bulfinch Triangle

- The Bulfinch Triangle, a 6-block area bounded by Causeway, Congress, New Chardon and Canal Streets is a National Register District. It is almost exclusively commercial in character with restaurants, retail businesses and offices.

4. Causeway Street/North Station/Boston Garden

- North Station area is a terminus of commuter rail lines servicing the northern suburbs, as well as a major sporting and entertainment events center. As such, it generates large amounts of pedestrian and vehicular traffic.

- Traffic volume on Causeway Street between Canal Street and North Washington Street is heavy due to:

    - The I-93 northbound off-ramp and I-93 southbound on-ramp (the I-93 northbound off-ramp is also a CANA detour route)

    - Boston Garden Events, when both pedestrian traffic and on-street equipment truck parking is heavy

    - Its connection to the North Washington Street Bridge

5. Valenti Way/Medford Street

- Braman Dow which fronts on Medford Street relies on vehicular access from Valenti Way.

6. North End

- Boston's North End is a semicircular area located north of downtown between the harbor and the elevated Central Artery. The North End is a residential, predominantly Italian-American, inner-city neighborhood renown for its restaurants, coffee shops, bakeries, grocery stores and meat markets.

- Residents and visitors alike traverse the busy streets that surround the North End. A key pedestrian connection currently runs under the Central Artery between Salem and Hanover Street. This is the route of the Freedom Trail, a pedestrian route linking many of Boston's revolutionary-period historic attractions.

- The portals of the Sumner and Callahan Tunnels lie at the southerly edge of the North End bringing large volumes of regional traffic to the periphery of the neighborhood. The Sumner portal frequently causes increased traffic on local streets as motorists search for short cuts.

- Because of its dense urban fabric, parking is a scarce commodity in the North End. Its charming, narrow, one-way streets are not well-suited for the automobile. Many of its inner streets have residential parking restrictions. Downtown office workers, visitors and shoppers currently use the parking lots under the Central Artery's viaduct structure located at the periphery of the North End. Once construction begins, this source of parking will disappear and is likely to bring increased parking demand on the remaining spaces.

7. Stillman Place

- The buildings and pavement at Stillman Place are on the Historic Register.

6.2.2 Existing Conditions Inventory

An inventory of existing conditions will be completed in the winter of 1991. Base maps indicating the following information will be provided to the SDC.

1. Vehicular Movement/Nodes (some traffic counts)
2. Pedestrian Movement (some pedestrian counts)
3. Building Uses and Entrances
4. Parking and Loading Zones
5. Historic Resources
6. Recreational/Tourist Uses
7. Other Construction Activity

6.3 Mitigation Requirements

Site-specific mitigation requirements are described below. Construction Impact Mitigation, found in Appendix A of the Scope of Services, outlines the general mitigation guidelines the SDC must follow.

1. Coordination

There must be coordination of construction activity with other simultaneous construction projects. The timeframes and staging of these construction activities must be considered in order to minimize construction impacts. These include, but are not limited to, the following:

- Parcel 7 garage (D016A)
- MBTA Green and Orange Line construction near North Station
- New North Station/Boston Garden
- CA/T contracts D014B, D014C, D017A, and D019A.

2. Traffic

- Maintain operations for MBTA bus routes 6, 42, 400, 426, 440, and 450
- Stage for the least possible traffic disruption to the following key areas:
- Maintain access to I-93 Northbound from North Street when the new Southbound ramp into the Callahan Tunnel from the underground artery is built.
- Maintain traffic flow resulting from the elimination of the on-ramp from Causeway Street to I-93 Southbound.
- Relocation of off-ramp from I-93 to New Chardon Street over the MBTA Green Line
- North Washington Street/Cooper Street intersection
- North Washington Street/New Chardon Street intersection
- Blackstone Street/New Sudbury Street - North Street
- Cross Street: Sumner Tunnel to North Washington Street
- Relocation of off-ramp from I-93 SB to North Street/Callahan Tunnel
- Relocation of on-ramp to I-93 SB from Sumner Tunnel/New Sudbury Street

3. Access

Construction must be staged to ensure pedestrian and/or vehicular access and flow to key locations at all times. These locations include, but are not limited to, the following: (For further details regarding architectural design standards for pedestrian crossings and access, refer to Section 7 of this document.)

- Pedestrian flow through the Freedom Trail crossing under the Artery from Hanover Street to Cross Street. A red line denoting the Freedom Trail must be maintained at this location at all times.

- Pedestrian, vehicular and loading access to the buildings and businesses along the Surface Artery between Endicott and Causeway Streets, icluding Purity Cheese, Stillman Place residences, and Joe Tecci's Restaurant.

- Pedestrian and vehicular access to Purity Cheese on the corner of Endicott and Cross Streets, particularly for milk truck access along Endicott Street. Additional information regarding the maintenance of access to Purity Cheese will be given to the SDC including preliminary staging drawings suggesting how pedestrian, vehicular and loading access can be maintained.

- Pedestrian and vehicular access to the Government Center Garage off New Sudbury Street.

- Pedestrian access to North Washington Street

- Bus and pedestrian access to Haymarket MBTA

- Pedestrian flow across Causeway Street

- Vehicular access to Braman Dow delivery area.

4. Construction parking and vehicular routes

Specify construction worker parking restrictions in the bid package. CA/T staff are investigating remote area parking for construction workers, with shuttle/public transportation to work sites. The SDC should coordinate specifications with Project remote parking plans.

Specify routes and restrictions for construction vehicles and machinery. CA/T staff will be developing enforcement mechanisms to minimize traffic congestion and noise and vibration impacts. The SDC should coordinate development of specification with the enforcement mechanisms, as well as with adjacent construction contracts identified in Section 6.3.1.

5. Parking

The business communities existing on both sides of the D015A portion of the Artery depend on the limited parking supply available. Delineate necessary lines of construction where parking will be taken, minimizing disruption and taking of existing spaces. These areas include, but are not limited to:

- Lots under the artery from North Street to Endicott Street.
- Street parking along Cross Street from Hanover to Endicott and along Endicott.
- From North Washington Street to Causeway Street under the northbound lane.
- From Causeway Street to Haverhill Street under southbound lanes.
- Coordinate parking plans with the traffic maintenance and parking requirements of the D014B Design Packages.
- Coordinate parking plans with the construction of the Parcel 7 (D016A) parking garage currently scheduled for completion in late 1993.

6. Noise and Vibration

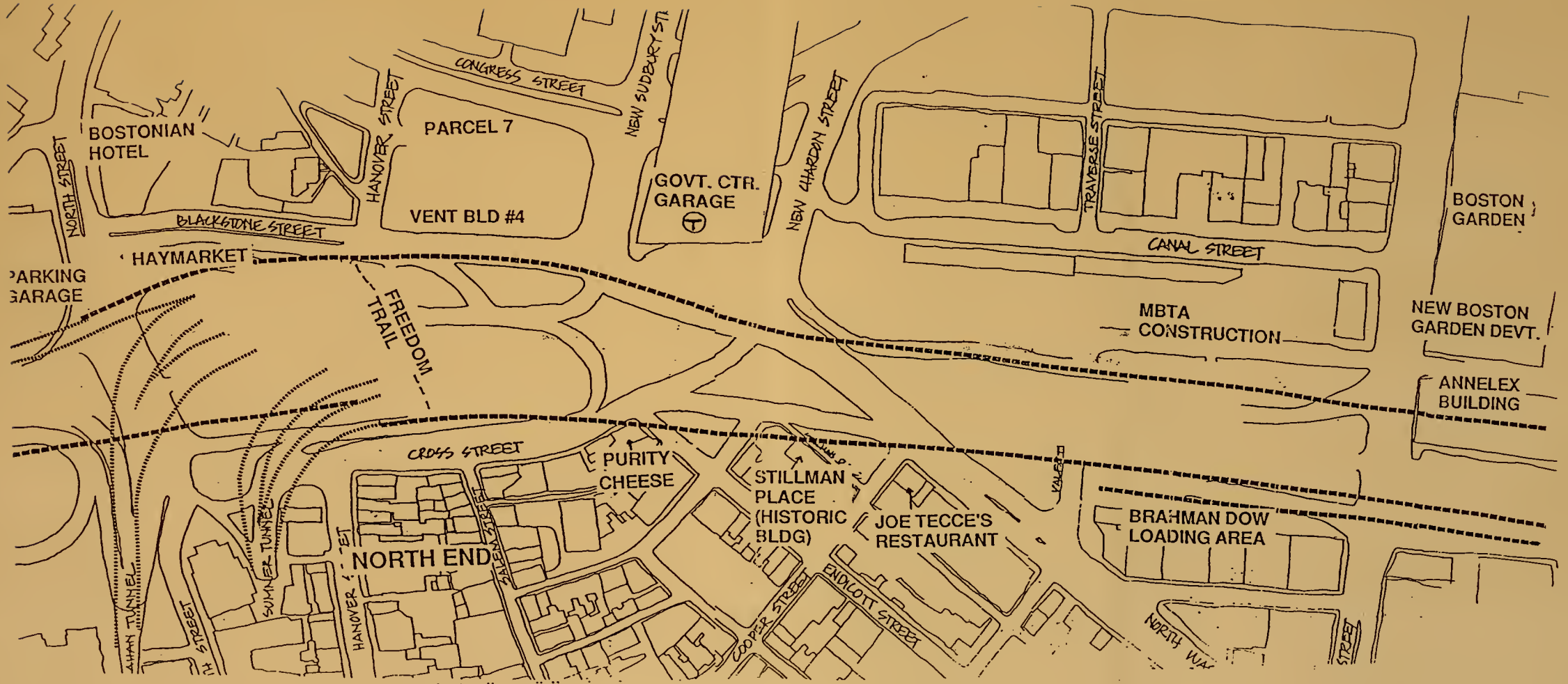
Specify noise abatement measures including methods for support wall excavation, and work hour restrictions which will be used to accommodate the needs of these sensitive residential and/or business locations.

- Construction activity will not be permitted in the Haymarket area parallel to Blackstone Street on Fridays or Saturdays in order to allow full functions of Haymarket activity.
- Residential areas of the North End from Hanover Street to North Washington Street on the east side, particularly along Cross Street.
- The Bostonian Hotel
- North Washington Street near Stillman Place and Cooper Street
- Cross Street near Endicott Street

7. Historic and Other Sensitive Structures

Specify methods which will be used to minimize construction impact on historic structures, and any other vulnerable structures in the D015A contract area which may require some form of special protection during construction. The SDC must determine what measures are necessary to protect adjacent buildings and convey this protection plan to the construction contractor via drawings and specifications in accordance with

the requirements of Section 3.2.5 of the Scope of Services. The SDC shall base its determination on at least (but not limited to) the Conservator's Report (December, 1988), the Area Geotechnical Consultant's Report, and their own additional studies.



DO15A I-93 CAUSEWAY TO NORTH

7.0 Architecture

7.1 Introduction

This chapter defines the scope of highway architecture, building architecture and landscape architecture in D015A. Included are both construction period elements, which are to be designed by the Section Designer and used by the construction contractor, and architectural and landscape design for the permanent highway elements, limited urban landscape areas and two buildings.

This scoping package covers all construction phases from slurry wall construction through decking and subsequent removal of the overhead Central Artery (approximately 1998) and opening of I-93 NB and SB. A temporary landscape condition on the surface is shown, identifying the condition in which the surface is to be left upon completion of the work in this contract.

It is assumed that a separate design contract will provide for the surface design solution, and that the D015A Section Design Consultant will be required to coordinate with the designer thereof. Design work relative to joint development of surface parcels is not included in the scope of this contract at this time. The management consultant with the MDPW is continuing to analyze potential physical impacts to the tunnel structure and systems based on land use proposals for available joint redevelopment parcels.

7.2 Urban Design

7.2.1 Urban Design Context

A well-considered urban design approach for the D015A section of the Artery will enrich the architectural and landscape architecture solutions put forward for the future renewal and development for the area. These designs need to be based on an understanding of both the older historical dynamics interrupted by the construction of the Artery and existing conditions which, in part, reflect the impact of the Artery itself over the past 30 years.

When the elevated artery was built in the 1950's, it arbitrarily disrupted the continuity of pre-existing street patterns. The separate character of each of the neighborhoods severed by the Artery is shown in Urban Design Map No. 1. Particularly relevant to D015A are the distinctive street patterns associated with the Bulfinch Triangle and the North End. These clearly emphasized movement across the Artery towards the harbor edge along a series of straight and long streets fanning out from the old business district. Map No. 1 demonstrates that the Artery alignment was determined without reference to any historic or contemporary pattern of movement through the downtown. It obliterated almost half of the Bulfinch Triangle whose apex was originally located where the

bus terminal now operates under the new Government Center Garage. The Artery also destroyed the interface between the North End and the downtown area. The destruction of many of these traditional movement patterns reinforces the need for construction period protection of those links that have survived. It also brings to the fore the need for interim final as well as permanent restoration plans.

Though the existing Artery is thought of as a corridor which cuts a regular swath across downtown Boston, its impact on the configuration of the abutting street pattern has been very varied along the entire length of the downtown section. This is the result of both direct and indirect property right-of-way takings for the elevated roadway which transformed formerly active streets and truncated buildings into Artery edges. Over time the presence of the elevated roadway itself began to influence the conditions along the highway edges, contributing to changes or decline in use, often creating dead or only sporadically active street edges in areas made inaccessible, dark and/or dangerous. Urban Design Map No. 2 summarizes the current uses along the Artery edges. It distinguishes between those building edges which are in active use (whether by pedestrians, vehicles or both) and those which are wholly inactive. Urban Design Map No. 3 roughly illustrates the extent and shape of open space (defined by street edges and buildings) that the removal of the elevated section of the artery will expose.

The width of many of the gaps that will be opened up and the variety of their configuration, eg., angled to and set back from rather than running parallel to the former roadway opens up considerable possibilities for their subsequent re-use. In particular, the potentially generous open space can be employed to enhance the restoration of cross links between the waterfront and downtown, without impeding movement along the former artery alignment. The width of these openings and the visual interest of the irregular street edges lend themselves to the creation of public squares (open plazas or "nodes") through which important cross links pass. These would work to restore the traffic patterns which were interrupted by the elevated Artery while at the same time balancing the emphasis of north-south traffic which it imposed.

The depression of the Artery provides an opportunity to draw up an urban design framework which looks at the restoration of currently disused areas along the Artery edges together with future air rights development on the new land parcels above the tunnel. The commitment to reconnect and add selected thoroughfares across the Artery corridor must be considered together with analyses of the architectural character and existing street and traffic patterns specific to each sub-area. These will form the basis of urban design guidelines which will be developed as part of the surface restoration contract. They will be formulated to promote a consistent approach to the enhancement and addition of public urban space in the downtown area, whatever the actual sequence of development.

7.2.2 Neighborhood Characteristics

The Section D015A area includes three neighborhoods and/or districts with distinct characteristics with respect to building mass, height, street pattern and land use which, in combination, comprise the area's overall profile characteristics. The three districts are the Bulfinch Triangle, the North End and the Blackstone Block. (See Community Coordination section for further description.)

The Bulfinch Triangle

The Bulfinch Triangle is an historic district which was split by the Central Artery. Almost half of the Bulfinch Triangle was razed to make room for the Central Artery. Named after its designer and shape, the Bulfinch Triangle is a mixed-use district with retail stores, restaurants, and office space. Since most of the buildings here are four to eight stories high and made of brick with similar and compatible architectural elements, the district has a unified and distinctive visual character. It is experiencing extensive private revitalization after several years of neglect including mixed use redevelopment of Boston Garden. The current efforts to revitalize the district promise to make it an attractive area for pedestrian activity.

The North End

Beyond the Artery, to the east of the Blackstone Block, is the North End, primarily a residential area with ground floor commercial/retail uses on the major streets. This historic neighborhood has been described by Jane Jacobs as most unique and successful urban neighborhoods in the U.S. An area of historic buildings such as the Paul Revere House and Old North Church, this neighborhood has narrow streets lined with brick buildings (all under 60 feet in height) and retail stores and restaurants that create a human-scaled, warm and casual environment in which pedestrian activites thrive. Tourists and locals are drawn into the North End by its physical environment, its shops and restaurants, and its Italian-American festivals. According to pedestrian counts made in November 1988 for this project, 1,614 persons passed under the Artery along the special Freedom Trail walkway during the midday peak hour in November. August 1989 peak hour pedestrian volumes of 1,300-2,000 were documented. Many more use it on days when the Haymarket food stalls are open and during the summer tourist season.

The Blackstone Block (Part of the North End Prior to Artery Construction)

The Blackstone Block consists almost entirely of historic buildings which are under 60 feet in height (one to five stories). The newest addition, the Bostonian Hotel built in the mid-1980's, is compatible with the rest of the buildings in the block, almost all of which are made of red brick. With its small-scale building, narrow streets, and informal street pattern, the Blackstone Block is a classic example of old Boston urban design and architecture and of the way such factors foster pedestrian activity. Between the Blackstone Block and the Central Artery is Blackstone Street, where the Haymarket fresh food vendors convene every Friday and Saturday. On market days Blackstone Street becomes a sea of pedestrians. The overwhelming presence of the adjacent Central Artery and its vehicular traffic, which create the outside edge to this street market area, is virtually ignored by the thousands of shoppers.

North of the Blackstone Block is an undeveloped lot (the site of Parcel 7 development - see Section 7.4.1) where the entrance/exit kiosk to the underground Haymarket MBTA station and a BRA employee parking lot are located.

Within or along the fringes of these distinctive neighborhoods are many individual buildings of considerable historic interest which abut the existing Artery. These range from a preserved mid-eighteenth century row of townhouses on Stillman Place through late Victorian industrial and commercial buildings on Endicott Street to what is now known as the Boston Police Academy Building built in 1931 just north of the Sumner Tunnel. The likely impact of the new Artery tunnel on the condition and structure of these buildings (many of which are listed in the National Register of Historic Buildings) has been estimated in the Preliminary Study Report of the CA/T Project Conservator (December 1988).

7.3 Highway Architecture

7.3.1 Portals, Ramps and Boat Section Walls

Portals

Portals to be designed in this contract (see Drawing Nos. AR8-PD-001 thru AR8-PD-H-009) include the mainline I-93 NB and SB portal at Causeway Street and a series of ramp portals, as follows:

a. Ramp portals which daylight near New Chardon Street are ramps SA-CS/SA-CT which are divided with a gore (Surface Artery to the Callahan Tunnel and Surface Artery to I-93 SB);

b. Exit ramp portal SA-CS from the Sumner Tunnel to the Surface Artery; and,

c. Portals at boat sections adjacent to the Callahan and Sumner Tunnels leading to ST-SA to the Surface Artery and ST-CN to I-93 NB.

The design of portals is intended to differentiate between the mainline and ramp portals. The mainline portal facade is designed with the projectwide standard of precast concrete ribs stepped back in plan and section with an exit portal distinguished from the entry by inverting the facade to indicate traffic direction. Use of the project standard emphasizes the mainline and establishes the Causeway portal as part of the overall highway architecture.

Ramp portals are to be expressed as a continuation of the adjacent boat section wall enclosure; these urban portals are not designed to appear as separate visual elements. The ramp portals shall be stone or rusticated consistent with the boat wall surface pattern, and shall provide a field for the coordinated location and mounting of traffic control equipment and signals. Landscape planters may be integrated into the portal wall design where indicated.

Ramps and Boat Section Walls

Urban ramps are designed to allow for the visual differentiation between on-ramps and off-ramps when seen from city streets. Entries and exits will be designed as gateways integrating signage, boat walls, pilasters and overheight attenuators. The ramps, boat sections and related secondary lights, signs, and railings are the elements of the highway which must be most closely integrated with the urban fabric at the surface.

Rustication, or patterning, on ramp retaining walls in this contract will be consistent with the Project Design Criteria, i.e., a combination of vertical and horizontal scoring. The direction, spacing and size of the score lines will vary for each ramp's geometry. (See Directive Drawings DD-H-107, 108, 109).

Pilasters are located 70 feet on center unless noted otherwise. At this time, no joint development consideration is required. Secondary elements, such as signs, graphics and lighting supports, are to be located in coordination with the regular spacing of pilasters to achieve overall design goals expressed in the Highway Architecture Concept Report.

A vertical architectural pylon is located at the exits from and entrances to ramps. It will identify the Interstate Highway System. This element will make the entry/exit more visible to surface drivers and to those driving cars merging onto city streets. It also serves as a safety warning to pedestrians, particularly at the exit ramps where vehicles are not readily visible until close to the exit nosing. It also alerts pedestrians walking next to a ramp that there will be traffic on both sides.

The pylon is designed as a support for the high vehicle attenuator at entrance ramps as well as signage if required. This structure (see drawing AR8-PD-H-020) will meet functional requirements to visually distinguish the urban ramp entry for the benefit of surface drivers and pedestrians and to provide a vertical sign support.

On the at-grade surface side of the ramps, portals and retaining walls a zone will exist which must be designated to relate to the surrounding urban condition; including sidewalks, open space, buildings and streets.

Since the final restoration of the surface is not in this contract, the design of walls related to the highway must anticipate a future final surface restoration: grading, paving, planting and site improvements.

The interim design of surface treatment in these zones should provide for safe vehicular and pedestrian movement. In addition, it provides an opportunity to express local considerations, such as neighborhood history and character through art and urban space development, enhancing the rich pedestrian environment for which Boston is well known.

The surface side of the permanent retaining walls will be designed within a family of treatments, including a pedestrian-scale treatment for seating, planting, lighting, walkways and signage.

The vehicle side of the ramp walls will be designed to accommodate the construction constraints of the slurry wall and cast-in-place walls. A cast-in-place finish surface will be attached to the slurry wall. At the C.I.P. finish wall, the batter, shape and texture of the finish will be as described in the Directive Drawings.

Architectural finishes at the ramps will vary in length, form, height and depth. Treatment of parapet walls will be stone veneer with a continuous pedestrian rail.

Gore wall conditions at ramps SA-CS/CASB, CS-SA/CS-CT, CS-ST/SA-CT, ST-SA/ST-CN and ST-CN/CANB will receive architectural treatment to forewarn drivers of merging or diverging roadways. Common walls, where possible, are framed and opened to allow visual penetration to and from the merging lanes.

7.3.2 Tunnel Egress

7.3.2.1 Objectives

To provide for the life safety of tunnel occupants in the event of an incident within one of the tunnel bores, the following design objectives have been established:

A) Area of Refuge

An area of refuge shall be accessible to all tunnel occupants within a 1 minute walk. At 2.5 ft./second walking speed, the maximum distance to an area of refuge shall be 150 feet.

An area of refuge is defined as an area along an exit path protected on all sides by two (2) hour rated walls, and one and one-half (1 1/2) hour Class B doors. Directional signs indicating the direction to the area of refuge shall be provided where the direction of travel to reach the area of refuge is not immediately apparent.

B) Area of Safety

In addition to the areas of refuge described above, an area of safety shall be accessible to all tunnel occupants within a 3 minute walk. At 2.7 ft./second walking speed, the maximum distance to an area of safety shall be 500 feet.

An area of safety is defined as an open space of Type 1 or Type 2 construction with natural or mechanical ventilation. It shall be clearly designated as an area of safety in case of fire. Directional signs indicating the direction to the area of safety shall be provided where the direction of travel to reach the area of safety is not immediately apparent.

The following settings, in order of preference, shall be considered points of safety:

1. Any point at grade or open to the sky boat section.

2. A protected stairwell leading to grade.

3. A protected passage leading to the basement or another space in an adjacent building along the alignment.

4. A protected space with independent life support system in which tunnel occupants can wait in safety for the arrival of rescue teams.

5. For the tunnel design, an adjacent incident-free tunnel bore shall be considered a point of safety. Cross passages from one bore to another shall be provided every 300'.

Points of safety shall be located a maximum of 1000' from each other.

C. Tunnel Occupancy

Bumper to bumper traffic in the tunnel is assumed as the worse case situation:

TABLE 7.1: Tunnel Occupancy Calculations

Assumptions	Resultant Persons/Lane
Average auto length = 20' # autos/1000' lane = 50 # persons/auto = 1.2	60 persons/1000' lane
# buses/1000' lane = 0.5 # persons/bus = 40	20 persons/1000' lane
	Total: 80 persons/1000'lane

D. Exit Capacities

The following capacities are from NFPA 130 Fixed Rail Transitway Code.

1) Exit capacities shall be measured on the basis of 22" wide exit lanes. Fractions shall not be counted except that 12" added to a lane shall be counted as 1/2 a lane.

2) Minimum width of egress path - 36"at doors
44" on stairs
68" on surface of 4% slope or less
72" on ramps of 4% slope or more

3) Capacity per exit lane - 35 ppm on stairs or ramps "up"
40 ppm on stairs or ramps "down"
50 ppm on surfaces of 4% slope or less
50 ppm at doors

7.3.2.2 Architectural Design

Based on the preceding objectives, the design of tunnel egress has proceeded as follows:

A) Cross Passages

Beginning at Causeway Street (Station 164) cross passage locations were selected every 300' along the mainline bores, and within 300' along the ramp bores. Thus mainline cross passages are located at stations 161, 158, 155, 152, 149, 146, and 143. In addition, ramp cross passages are located in the following locations:

- CANB (152+00) to ST-CN (52+00)
- CASB (149+00) to CS-SA/CT (49+50)
- ST-SA (50+50) to ST-CN (50+00)
- ST-SA (47+50) to ST-CN (47+00)
- ST-SA (47+50) to SA-CT (46+75)
- SA-CS (46+00) to CS-SA/CT (46+50)
- SA-CT (44+00) to CS-CT (43+50)

Ramps or stairs are used to link the differences in elevation between bores.

B) Egress Stairs

Egress stair entrances have been located at alignment stations at which cross passageways are also located to maintain 300' spacing between egress points.

In general, the preferred location for egress stairwells is within gores or between adjacent bores rather than outside of the tunnel slurry walls. However, this approach has not been possible within the Contract D015A limits.

Potential stairwell locations were tested against the following constraints:

1. There must be less than 1000' between points of safety.

2. There must be space either within a gore, within the structure of the tunnel bores, or outside of the slurry wall, to locate a stairwell.

3. There must be at least one nearby open space at grade in which to locate the headhouse which does not conflict with the proposed surface street, urban design, or joint development plans.

4. There must be a clear vertical and/or horizontal path from the tunnel level to the headhouse site which does not conflict with the new utility locations.

Based on these criteria, the following stairwell locations have been determined:

- Station 158, exit from northbound bore
- Station 152, exit from southbound bore
- Station 146, exit from northbound bore

The stairwells are spaced substantially less than 1000' apart. This is due to the difficulty of finding suitable headhouse sites spaced an even 900' apart, the desire to keep the required stairwell and headhouse sizes manageable, and the expectation that some established locations may be altered in the future.

C) Occupant Behavior

In order to properly size both the crossovers and stairwells for egress load, the following guidelines were developed:

1) A single incident location is assumed. Multiple incidents per location should be evaluated in later design stages, and accommodated within the design if possible.

2) Occupants in the same lane as the incident and within approximately 1000 feet will act as follows:

* They will move away from the incident.
* They will attempt to cross over to another area of safety unless an egress stairway is equidistant with the nearest cross passage and in the same direction (ie. away from the incident). Then the stairs will be chosen.
* They will not cross back to the lane containing the incident for any reason.

3) Occupants in a lane adjacent to the incident and in its immediate vicinity may be aware of the location of the incident via information from those crossing over and shall move away from the incident as well.

4) All occupants outside of the vicinity of the incident are assumed to go the nearest stairway or ramp regardless of direction of motion.

For each cross passage and stairwell, various incident locations were assumed, and the resultant egress load was calculated. The worst-case load was used to size the means of egress.

D) Egress Structures

The new emergency egress/access structures fall into four categories:

1. Headhouses adjacent to new ramp boat walls and exiting to the ramp walkway.

2. Headhouses located on parcels likely to be jointly developed in the future.

3. Headhouses located on parcels likely to remain undeveloped.

Overall, the headhouse design shall identify the elements as part of the CA/T project by use of the same family of materials and forms as other CA/T architecture. At the same time, each headhouse must be successfully integrated with its immediate surroundings to minimize its physical presence.

In particular:

1. Headhouses adjacent to boat walls shall be fully integrated with the boatwalls both in form and material. See PD-H-006

2. Headhouses located on parcels likely to be jointly developed shall be designed as freestanding elements which are likely to be fully subsumed or substantially altered by the future site development. During the interim period between project completion and joint development, they are likely to be the sole occupants of these sites.

3. Headhouses located on parcels likely to remain undeveloped shall be designed as permanent elements.

E. Interim Maintenance of Tunnel Egress

Cross-passages and egress structures are located per section 7.3.2.2. paragraphs A) and B) of this report. Their locations assume a final construction condition in which both the I-93 North and South bound bores are operations. However, the I-93 North bound bore will be in operation prior to the opening of the I-93 South bound bore.

The Final Section Designer must review the construction sequence and staging for D015A, land must design temporary egress structures, landings, stairs, rails and any other associated life safety items for the interim use of the permanent cross-passages and stair egress structures. Egress from the I-93 North bound bore must be maintained.

The evaluation and design of the interim egress facilities shall include but not be limited to:

1. Review of proposed construction sequencing and staging,
2. review of Project Design Criteria,
3. review of proposed permanent cross-passage and egress structure locations with regard to final surface conditions and interim surface conditions,
4. review of related final design contracts by others as referenced in Section 1.4 of the report,
5. review of existing artery and underpinning locations, and
6. review of temporary structures for traffic and pedestrian maintenance during construction.

The design of the interim egress facilities shall be in accordance with the Project Design Criteria.

7.3.3 Tunnel Finishes

The goals for the final design of the architectural finishes in the I-93 tunnel are as follows:

A. Driver safety and Orientation

Architectural finishes provide lane definition, assist in the legibility of signage, support rapid identification of cross passages/emergency exits and support the ambient light levels required for driver visibility. Graphics in the tunnel finishes will assist drivers in understanding their geographic location.

B. Ease of Maintenance

Architectural finishes should minimize facility and replacement costs. This will be accomplished by specifying appropriate materials which create surfaces that are easy to clean with standard tunnel wash equipment, and which resist corrosion related to entry of water into the finishes and connections.

C. Aesthetic

Architectural finishes provide a more pleasing aesthetic experience for drivers which in turn will provide the driver with a sense of security and confidence while driving through a restricted underground environment.

7.3.3.1 Wall Finishes

The wall finish selected for the I-93 Central Area tunnel will be a separate finish wall, consisting of a glazed high density ceramic tile (consistent with Project Design Criteria, Section VI - Architectural Article 2.3.4 Tunnel Walls). The wall finish, should measure approximately 6 inches in thickness. Grout color should be selected such that the joints are not highlighted. Tile joints should be normal to the roadway. Allowance for expansion of the tile work should be provided 15' on center and whenever expansion joints in the structure are provided as a minimum. Wall panel shall be removable at standpipe locations.

Ventilation ports at side-exhausted tunnels are required. Spacing and size of ports are per D020B consultant. This consultant shall coordinate ports for alignment to wall, ceilings, and graphic design.

Wall finish at portal flank walls is to be polymer concrete. Close coordination with the portal design is required.

The graphic design for the tunnel finishes will be developed by the Graphic Design consultant and coordinated by this final section consultant around the following general guidelines:

1. Graphics are to be created by tile arrangement patterns, glazed tile surface patterns, or combination of both in conjunction with other tunnel finish elements. The size of the tile is to be determined by the Section Design Consultant in conjunction with the graphic design. Tile joints are to be normal to the roadway elevation.

2. Graphics are to be two-dimensional, and shall not cause protrusions from the wall finish surface nor create joints where corrosion might occur.

3. Graphic treatment on the walls of the tunnel should also reinforce lighting zones. The general design approach, including the colors to be used on the tunnel walls and ceilings, is provided in the Graphic Design Guidelines Manual, an appendix to the Architectural Design Criteria. Signage for utility rooms, cross passages, egress stairs, colors, for standpipes, fire extinguishers, colors for handrails and any visible sign supports will also be specified in the Graphic Design Manual.

   The SDC shall develop the graphic treatment in conjunction with the graphic design consultant.

7.3.3.2 Ceiling Finishes

The tunnel ceiling finish is to be concrete-filled porcelain enameled panels, as described in Article 2.3.3

Tunnel Ceiling Systems of the Project Design Criteria, Section VI - Architectural. The ceiling is suspended below the tunnel roof slab with a structural support system (see Section Structural Design) to form the tunnel exhaust air plenum. At certain locations, the ceiling panels will be attached directly to the tunnel roof slab. The ceiling will be installed horizontally when viewed in cross section rather than be superelevated with the roadway (see Preliminary Design Drawings). Gaskets shall be provided between panels to provide an air-tight seal for ceilings that serve to create the exhaust air plenum.

The ceiling panel design and configuration act to reinforce the spatial distinction between travel lanes and shoulder or gore areas in two ways. First, those panels located over the travel lanes shall be colored white, while those over shoulder areas shall be grey. Secondly, the grey panels shall be recessed in relation to the white panels. The transition between the tile wall finishes and the ceiling panels is to be

accomplished by means of a flexible coved element. (See Drawing AR8-PD-H-041). White panels shall continue into the portal facade to emphasize lane locations. The ceiling panels shall be removable and structural supports shall be detailed to provide for expansion and contraction due to temperature change. The cove panels shall be removable at Utility Room Locations from the roadway level.

Lighting Fixtures/Ceiling Panel Interface

Lighting fixtures are to be mounted in a continuous trough centered over lane markers in the tunnel. The trough is a corrosion protected steel channel into which the luminaire is inserted. The fastening of the trough to the ceilings and of the lights to the trough will be detailed to be corrosion-proof. Spacing of the luminaires shall be as regular and uniform as possible. The spacings, numbers and locations of the fixtures are shown on the Electrical Directive Drawings.

A special lighting fixture is required to illuminate signs. This fixture will be attached to the ceiling system. All holes in ceiling panels are to be pre-punched before ceiling finish is applied. All lighting fixtures will be furnished and installed by others.

Signage/Ceiling Panel Interface

Roadway signs are supported by sign mounts which are in turn supported by the tunnel structure (see Section 5.0 Structural Design). The support structure requires provision of prefabricated openings in the ceiling panels, through which the sign mounts will hang. These openings are shown on Drawing DD-H-002. The sizes and locations of these openings shall be coordinated with the D022A Section Design Consultant. Sign alignment is parallel to the ceiling alignment.

Ventilation/Ceiling Panel Interface

Ventilation air ports will be fabricated into the ceiling panels (see Drawing DD-H-001). These ports will be located and sized by the D020B Section Design Consultant. The air ports will be fitted with an adjustable closure plate to control the opening size and consequent air exchange volumes. The closure plate will be coated with a corrosion protection material and mounted on the top surface of the ceiling panel. The fastening will be detailed to be corrosion-proof. The development of final details of the air ports will require close coordination with the D022B Section design Consultant.

Miscellaneous Interfaces

The Integrated Project Control System will require equipment such as Closed Circuit Television (CCTV), AM/FM Rebroadcast and linear thermal heat sensors. Embedments for equipment and their supports are the responsibility of the D015A SDC. Coordination with the D020B and D022A SDC will be required.

D015A SDC will coordinate with adjacent D017A SDC for all tunnel finishes.

7.3.3.3 Walkway Finishes

Tunnel walkway finishes are to be consistent with Article 2.3.5 Tunnel Walkways of the Project Design Criteria, Section VI - Architectural. These consist of facing panels of precast polymer concrete. Polymer concrete will extend to the transition walls of the portal facade. Three non-typical conditions exist, as follows:

1. The continuous linear recess above the curb on both sides of the roadway is interrupted at supply air flue locations. The recess is to be dark in color to minimize the visibility of the flue locations as shown on the Architectural Standard Drawing SD-H-002.

2. At the tunnel portal where the walkway meets the roadway grade.

3. Non-typical panels exist where dimensions must be adjusted to respond to alignment curvature cross-over stairs or other dimensional variance. These panels will be sized according to unique dimensional requirements in each instance.

7.3.3.4 Roadway Level Entrances

Cross Passages

Cross passages connect separate tunnel bores and may be either within or independent of tunnel structural walls. The primary purpose is to provide an escape path from one bore to another. In some cases the cross passages may be combined with utility rooms and adequate space should be provided to accomplish both functions. Limited space for fire protection and communications equipment in the tunnel may be required in the tunnel. (See 11.0 Electrical Systems, and Section 12.0 Integrated Project Controls System (IPCS), and Sections 10.0 Mechanical Systems).

Materials and finishes are to be consistent with the Project Design Criteria, Section VI - Architectural, Article 2.8.5 Utility Rooms and Cross Passages.

Doors or pairs of doors will be operated with a sliding mechanism, since swinging doors could obstruct the walkways and impede emergency egress (approval of the Boston Fire Department will be required). Walls and doors shall be fire-rated.

Emergency egress signs shall be provided by the D015A SDC. Graphics associated with all rooms should convey their

identification number and the availability of telephone, fire extinguisher or other life safety features. Design of graphics for signage is by others. Coordination will be required. The Section Design Consultant shall incorporate the approved graphic design concept into the design drawings.

Utility Rooms

Utility rooms are provided, materials and finishes are to be as described for cross passages above. Panel walls are to be designed to support the equipment shown on the directive drawings. Equipment weights, dimensions, and connection details must be coordinated with the D020B and D022A Section Design Consultants.

Low Point Pump Stations

Low point pump stations (LPPS) are anticipated. The finish details for the LPPS are similar to those described above for the cross passage.

7.3.3.5 Handrails and Guardrails

All handrails must meet applicable dimensional and strength requirements. Guardrails will be provided at crossovers. Refer to Projectwide Criteria.

7.3.3.6 Wall Openings

Wall Openings will be provided in the structural wall to accommodate fire extinguishers and standpipe hose valves. White porcelain enameled steel doors will be provided at each of these locations to protect this equipment from the tunnel environment. These doors are to be designed by the SDC. See D020B Drawing SD-M-013. The wall chase for the hose valve opening shall be removable tile panel.

7.3.4 Secondary Elements

Traffic signals, signage, fire protection, security, communications, and lighting are not in this contract; they are in the scope of Section Design Contract D022A. The location of sign supports will be coordinated in this contract. It is important that locations of sign supports be located within the dimensional framework of the ramp architectural grid, integrated within the architecture of the pilaster and walls which define the roadway. Ramps, pilasters are spaced 70'-0" on center (unless noted otherwise).

Consistent with the Projectwide Design Criteria, ramp lighting will be mounted at the pilasters. Signage and over-height vehicle attenuators will be mounted at the ramp pylons. Embedments for all lighting will be in this contract. Coordination is required.

In the urban areas where the portals and ramps meet city streets, protective screening is not desirable. However, it may be desirable to use landscape planters integrated with the boat and portal walls to maintain a greater separation of pedestrian to vehicular traffic. These elements will vary according to the specific site and parcel development anticipated.

7.3.5 Construction Period Kit of Parts

A system of construction period elements has been designed to provide a "kit of parts" from which a variety of modular walkways, protective screens and supporting signage can be assembled to help mitigate pedestrian passage through construction zones.

The covered walkway system is protective, flexible, movable and durable and creates an environment which the user perceives as secure and comfortable. Design criteria for the walkways and associated elements are and illustrated on, Standard Drawings SD-H-401, 402, 403 summarized in Section 7.3.6 below. Criteria governing the location and various applications of the kit-of-parts within or adjacent to construction zones are illustrated below in Mitigation Drawings Nos. 1 and 2. They illustrate the application of the kit-of-parts to slurry construction, decking construction and excavation mitigation.

Within the D015A area there is one major pedestrian crossing - the Freedom Trail - which runs between Salem and Hanover Streets. A special thematic gateway will be designed for the entrances to this walkway which reflects its current and historical role within the downtown area. Gateway design imagery may also be enhanced through the use of secondary kit-of-parts elements, eg., kiosks with signage, planters, trash receptacles. The final designer will design the thematic gateway panels with reference to the Graphic Design Manual.

Other existing pedestrian pathways across the Artery will also incorporate gateway structures which must be maintained in a safe and usable manner at all times during the construction period. They include the following crossings:

- Causeway
- Washington Street to New Chardon Street
- Cross Street to Sudbury Street

These crossings together with the Freedom Trail are located on Mitigation Drawing 3 below.

Preliminary Design Drawings (AR8-PD-L 011, 012, 013, and 015) identify the locations of walkways and areas within D015A requiring some form of mitigation for pedestrians.

7.3.6 Construction Kit of Parts: Criteria for Use

Mitigation measures must provide for the comfort and convenience of both drivers and pedestrians travelling through or

near construction activity. Three northbound and three southbound lanes of surface traffic flanking construction zones must be maintained throughout all construction stages. Safe crossings must also be maintained on surrounding local streets directly affected by construction activity.

Kit of Parts: Modular System for Pedestrian Protection and Information

A system of modular walkways, protective fencing and supporting signage can be assembled from a "kit of parts" to help mitigate pedestrian passage through and adjacent to construction zones (see DD-H-402). The interchangeable elements will be coordinated to create a visually integrated set of components which will be easily recognizable to pedestrians and drivers. The system includes:

1. Pedestrian Covered Walkway

A modular shelter based on flexible system of elements will be used to provide overhead pedestrian protection from inclement weather and airborne construction debris. The shelter will be flexible, movable and durable as well as welcoming and reassuring to the public. (see DD-H-401, 402).

Each walkway shall be designed to:

- have a typical clear internal section of 8'0" x 8'0" to accommodate three people travelling abreast (with two in wheelchairs); the minimum allowable width will be 6'0";
- accommodate wall panels that are open to natural ventilation except where they must be solid for purposes of visual display or additional protection; solid panels must be painted in compliance with project-wide graphic standards; where used for protection, they must include glazed viewholes. (See DD-H-401 Panel Types);
- accommodate variably angled turnings (from 5 degrees to 90 degrees) over its length while maintaining a continuous waterproof enclosure, a non-skid walking surface and maximum change in grade between walkway sections of 1/2 inch;
- maintain an even walking surface; over areas with uneven ground conditions, walkway sections may be jacked or may sit on top of evenly spread levelling material;
- accommodate continuous roofing for protection from weather, dust and debris, joints between walkway sections must be covered;
- provide lighting at each 10 foot bay;

- o accommodate lateral openings along its length to permit access to shops or buildings where necessary;

- o be accessible to people with disabilities according to criteria set out by the Massachusetts Architectural Barriers Board, providing ramps with maximum slope of 1:12 to all walkways and maintaining them throughout the construction period;

- o incorporate sign bands inside walkway and on any visible exterior edge (see DD-H-401); project-wide graphics shall be applied to wall panels and roofing, as appropriate (see Project Graphic Design Manual, Appendix).

2. Gateway Structures

All covered walkways crossing the Artery corridor will incorporate gateway structures (Drawing SD-H-403) built by the contractor which will flank the entries at both ends. These structures will have special graphic panels applied to them, designed by the final designer with reference to the Graphic Design Manual. For crossings of special significance (the Freedom Trail, Walk to the Sea, State Street), gateway design will draw on some aspect of local historical significance to create an appropriate sense of place for each location. Though the walkways at these major crossings (identified in the Preliminary Design Reports) may be relocated several times within a designated crossing zone, the gateway structures leading to them should be installed beyond the slurry walls at the edge of the construction zone so that they can remain in place throughout the construction period (see DD-H-403). For other cross-corridor walkways, gateway structures may either remain fixed or may move as the walkway itself is relocated. The height of gateway structures shall exceed the height of the covered walkway by a minimum of 1'6" and shall be located to be visible from a distance of 1/2 block. The gateway treatment must include colors and graphic elements common to the pedestrian protection and information system.

3. Information Kiosk

The kiosk will incorporate project-wide graphics which will supply way-finding assistance at or near the entrances to covered walkways (see DD-H-403).

4. Construction Barricade

The barricade will consist of a jersey barrier base with panels above, (see DD-H-403). A sign band displaying project-wide graphics will be affixed at the standard height above the panels.

5. Construction Fencing

Fencing will be chain link with a sign band at the standard height used for the covered walkway, information kiosk and construction barricade.

6. Planters, Trash Barrel, and Pedestrian Crossing Beacon

These will be manufactured products which will be visually linked to the kit of parts imagery through the use of project-wide graphics. A minimum of two trash barrels will be used at the entrances to each covered walkway. Planters shall be used outside of the construction zone to screen construction activity and fencing and to strengthen pedestrian awareness of gateway locations.

Kit-of-parts layouts shall be site-specific and designed by the final designer to follow construction phasing plans. Elements from the kit may be used for additional project-related purposes not specified here, e.g.., to provide covered shelters for tour bus operations.

Criteria for the Location and Applications of Pedestrian Walkways

1. Construction zones shall be separated from public access by continuous fencing and construction barricades, interrupted only be removable barriers used to allow the ingress and egress of equipment and construction materials.

2. For additional protection, temporary roadway protection shall be applied along the length of the site perimeter corresponding to the section of slurry wall under construction at any one time; this shall be moved along the perimeter, following the course of slurry wall activity. Where covering is required, it must be compatible with design and maintenance standards specified in DD-H-401, 402.

3. Established pedestrian crossings under the Artery shall be maintained throughout all construction stages and shall be separated from vehicular traffic.

4. The covered walkway will be employed at all times except when it is interrupted for the passage of traffic where safety striping and ramps will be provided. Walkways not passing directly below the Artery may be covered or uncovered, depending on their proximity to construction activity and the specific circumstances of each location.

5. Wherever possible, these walkways will maintain their existing width; where reduced by construction demands, a minimum allowable width of 6'0" shall be maintained.

6. Where walkways disgorge pedestrians into vehicular traffic, traffic signalling, lighting, safety striping on pavement or decking and pedestrian crossing beacons at each end of the walkway shall be provided to ensure safe passage in compliance with city requirements.

7. Where walkways begin or end at a mid-block location, provision must be made to guarantee wheel chair access, in compliance with state accessibility requirements for a corner location.

8. Where the boundary of construction activity occurs within 5' of an existing sidewalk or temporary pedestrian route, the pedestrian zone will be separated from construction activity by a continuous barrier and/or protective fencing (see DD-H-406, 407) for protection measures required by specific building operations).

9. Where moving traffic runs alongside pedestrian access and a curb no longer exists to separate them, a continuous jersey barrier will be used to distinguish the pedestrian zone from the vehicular zone.

10. Site perimeter fencing will sit between 10' - 12' beyond slurry wall activity. Where it is not possible to maintain a minimum (6'0") walkway width, pedestrian traffic must be rerouted; where necessary, protected pedestrian passageways shall be provided along the opposite flank of the construction zone, running parallel and adjacent to the north-south vehicular traffic. These walkways will be separated from the construction zone and from traffic by construction barricades or covered walkway sections. Information kiosks including site maps and directional signage shall occur wherever the existing path is disrupted.

11. Where there is a choice of location between two sides of an intersection, walkway shall be located on the side with the greater volume of pedestrian traffic.

Maintenance Provisions

Throughout the construction period, walkways must be properly maintained, kept lit, clean, dry, clear of snow and ice, painted; signage must remain legible and accurate as walkway changes location. This will be the responsibility of the contractor.

7.4 Building Architecture

Two buildings are to be designed in Section Design Contract D015A:

- "Parcel 7 Development", a 170,000 gross square foot mixed-use building which includes a ventilation structure, office space, retail and market space. It will be located adjacent to the alignment of the Surface Artery just northwest of the Blackstone Block in Boston's Haymarket area. Parcel 7 Development also includes a 350-space parking garage, the lobby for the MBTA Orange Line Haymarket Station and market space (Contract D016A) which is to be built before the building complex included in this contract.

- Emergency Station No. 7, a 5,000 gross square foot garage which houses emergency response tow trucks and personnel, located at the intersection of New Chardon Street and the surface artery.

The station is one of nine (9) emergency stations and platforms sited along I-90/I-93 discussed in the Emergency Station Location Report (forthcoming January 1991). The distribution of emergency vehicles and personnel for the Central Artery/Tunnel Project is determined by the need to maintain a response time that will allow projected traffic volumes in the tunnels to move quickly enough to meet Federal carbon monoxide exposure criteria.

Emergency Station #7's location at the corner of New Chardon Street also satisfies the terms of an agreement with the Boston Fire Department to keep emergency vehicles from interfering with the access of fire equipment to the Callahan Tunnel (see Map No. 4).

7.4.1 PARCEL 7 DEVELOPMENT

The Parcel 7 Development will be located on a 58,000 square foot lot (for both D015A and D016A Contracts) now used as a parking lot for city employees (see site location map below). The purpose of the project is to ventilate the I-93 tunnel, to replace parking spaces lost when the elevated highway is removed and to mitigate the impact of the ventilation equipment and structures on the surrounding historic area. All the elements of the approved architectural program are "Required Uses" listed in the "Design Guidelines and Standards" for the project developed in cooperation with the Boston Redevelopment Authority (BRA), and will be integrated into a single structure covering the entire lot.

The approved program elements, square footages, and design guideline summarized here are documented in detail in the following documents:

Central Artery (I-93)/Tunnel (I-90) Project: Preliminary Design Report, Parcel 7 Project, Section Design Contract D016A, Bechtel/Parsons Brinckerhoff and Wallace, Floyd Associates, revised September 1989.

Central Artery (I-93)/Tunnel (I-90) Project: Parcel 7 - Parking Garage, Design Contract No. D016A, Preliminary Engineering Submittal, Bechtel/Parsons Brinckerhoff, September 1989.

TABLE 7.2 : Parcel 7 Summary Building Program

Ventilation	107,200 gsf
Retail and Market Support	63,300
MBTA Lobby	4,600
Parking Garage	76,400
Commercial Office Space	43,500
Total Parcel 7	295,000 gsf
Total less garage (Section D015A)	170,000 gsf

The MDPW has agreed, as part of the environmental review process, to provide the replacement parking before the spaces under the existing artery are removed. The parking garage component of the Parcel 7 development will therefore be built in advance of the adjacent highway. The program elements are summarized below. D015A and D016A will be built in the following phases:

A. D016A - Parking Garage, MBTA station alterations, and ground level market space;

B. D015A - Ventilation structure, a part of market support space at subgrade 1 level;

C. D015A - Commercial office space, a part of ground level market.

Program Elements

Ventilation Structure (D015A)

The program allows 107,200 gross square feet at the second, third and fourth levels below grade as well as a part of the first subgrade level to house, service and maintain the fans, pumps, electrical equipment, and air ducts required to ventilate the new Central Artery between State and Causeway Streets. The ventilation stacks will rise 125 feet above grade, and will be "wrapped" by other program elements up to approximately 80 feet. Other above-grade ventilation elements include a 2,700 s.f. fresh air intake shaft and a fan/equipment loading service entrance.

Retail, Market Support and MBTA Lobby (D015A and D016A)

The program allows for a 32,900 gross square feet of retail area at ground level and 35,000 gross square feet of cold and dry market storage, mechanical, and maintenance space at the first level below grade. The retail area will include a 4,600 square foot lobby and handicapped accessible entrance to the existing MBTA Orange Line, and will be provided with handicapped accessible public toilets, all necessary structural, mechanical and electrical systems, for future tenant buildout. Final buildout for interior space will be carried out by others.

Commercial Office Space (D015A)

The program includes 43,500 gross square feet of commercial office space surrounding the vent stacks on five stories above the ground floor market along Blackstone Street. The space will minimize the visual impact of the stacks and make them compatible with the adjacent historic district, and will be provided with all necessary structural, mechanical and electrical systems. Final buildout for interior space will be carried out by others.

Parking Garage (D016A)

The program proposes a 76,400 gross square foot (excluding roof parking space), three level open parking structure (including roof space of 37,000 s.f.) above the retail area that will provide approximately 350 parking spaces, including handicapped parking required by code. Vehicles will enter from and exit to New Sudbury Street at ground level, go through a ticket and pay area, and proceed up interior two-way ramps to the parking levels above. Other program elements include storage and maintenance space, an employee toilet, and a management office.

The exterior walls of each story of the garage will be 50% open on at least two sides in accordance with the building code to allow for natural ventilation, and it will be laid out in 60 foot by 27 foot long-span bays.

7.4.2 EMERGENCY STATION No. 7

7.4.2.1 Site Context and Zoning

Emergency Station No. 7 is located on a visually prominent corner site. It is bounded by re-aligned New Chardon Street and the future surface street on its south and east sides, by MBTA tracks on its north side and Canal Street to the west (see following site plan). The prominence of the Emergency Station on this site derives from its exposure to traffic which surrounds it on two sides - coming off the existing Artery, to and from the bus terminal under the Government Center Garage and coming from New Chardon Street.
The area surrounding the site is characterised by sharply contrasting architectural styles. Immediately to the south sits the massive Government Center Garage whose front end occupies the tip of the original Bulfinch Triangle. Accommodating 1,600 parked cars with two floors of offices recently added on top and built of concrete with an exposed structure, the building is out of scale and strongly contrasts with its surroundings to the north.

The buildings to the west of the site along Canal Street form a pleasing and coherent passageway between North Station and the bus terminal currently operating at the ground level of the Government Center Parking Garage. On the west side of Canal Street is a collection of modest red brick buildings varying between four and six stories in height including the Furniture and Wakefield/ Rapids Buildings both built in the 1890's and both listed on the National Register of Historic Buildings. On the opposite side of the street, the Canal Street Building built in 1915 is of comparable height and runs down half the length of the block. It is clad in white terracotta tiling with sculpted detailing at the roof line and over doorways. The rear elevation of this building, unadorned brick with three levels of window openings, faces directly on to the western boundary of the Emergency Station Site. The Canal Street Building is also listed on the National Register.

The North End sits directly across the existing Artery from the site; in scale and in its use of brick, it resembles the Canal Street area. In the irregularity of its street grid and the narrowness of streets, it presents a distinctly different character to that adjacent to the Emergency Station No. 7 site.

Plans for the redevelopment of the MBTA Green/Orange Line station and for possible North Station air rights development over the entire parcel of land running between Causeway and New Chardon Streets. The renovation of the MBTA station will involve the creation of a new ventilation port (about 15' x 15') between the emergency station and an existing electricity substation north of the site boundary. Subsequent air rights development might involve either building up to or out over the new emergency station.

The bus terminal currently operating at the ground level of the Government Center parking garage might eventually be moved to this site once renovation of the Green line station is complete. This would clearly change the patterns of both pedestrian and vehicular movement around the site. Pedestrian traffic near the site is particularly heavy, primarily at commuter hours. The current intersection of New Chardon Street, the Surface Artery, and North Washington is particularly difficult to cross. Site entry and exit locations for tow vehicles should be located so as not to worsen pedestrian traffic conditions.

Zoning

The site falls within a restricted growth subdistrict of the downtown Interim Planning Overlay District (IPOD). This proposes a maximum allowable building height of 80 feet with an FAR of 6 (and a possibly enhanced height and FAR of 100 feet and 7, respectively). The underlying zoning district allows for a lower FAR of 4 and for restricted manufacturing use. The emergency station No. 7 site sits at the southernmost tip of the underlying triangular district to the west, a north-south sliver taking in both sides of Canal Street, it also falls within the same IPOD which would increase its allowable FAR from 2 to 6.

7.4.2.2 Architectural Program Summary

Purpose

Facility for Emergency Response Unit personnel and vehicles which:

1. provide motorist aid in the event of a traffic incident on I-93 tunnel and ramps;
2. remove disabled vehicles by towing;
3. assist in rescue of motorists;
4. provide first aid; and,
5. respond to minor fires.

Primary Activities

1. Communicating with emergency vehicles and Operations Control Center in South Boston.
2. Emergency Station crew members changing and showering, minor first aid.
3. Emergency equipment and vehicle storage.
4. Public assistance for motorists waiting for private towing or other services.
5. Minor emergency vehicle and equipment maintenance and repair.

Staffing Numbers		Crew Chief	Asst. Crew Chief	Tow Truck Personnel	Total
1st Shift	6	1	1	4	6
2nd Shift	6	1	1	4	6
3rd Shift	4	-	1	3	4
Total	16	2	3	11	16

Users

Emergency response unit crews, police personnel, building maintenance staff, members of public when accompanying a disabled vehicle.

On-Site Vehicles

2 emergency response tow truck vehicles
1 utility van
1 trailer-mounted arrow board
2 police cruisers
2 administration vehicles

Spatial Diagrams

1. Public Access Area
2. ERU Crew Support
3. Communications
4. Garage Bays
5. Emergency Crew Chief

Figure 1: Spatial and Site Program Relationships (attached)

Reference Key

PUBLIC ACCESS AREAS
1. Public street entry
2. Public waiting area
3. Public toilets
4. Kiosk-vehicle storage

ERU CREW SUPPORT
5. Lockers & showers (M&F)
6. Staff toilets (M&F)
7. Laundry/uniform storage

COMMUNICATIONS/OFFICES
8. Communications room
9. Day room/kitchenette
10. Crew chief office

GARAGE
11. 4 Vehicle Bays
12. Workbench area
13. Emergency equipment storage

BUILDING SUPPORT
14. Janitor
15. Mechanical/Electrical room
16. Service/Delivery entry

FIGURE 2: Room Relationships Diagram (attached)

TABLE 7.3: Space Groups and Room Sizes

Space Reference No. & Name	Occupancy	Preferred Size (S.F)
PUBLIC ACCESS AREAS		
1. Public street entry		100
2. Public waiting area & phones		120
3. Public toilets		160
Public Areas Subtotal	380	

	ERU CREW SUPPORT		
	4. Lockers & showers (M & F)	16	480
	5. Staff toilets (M & F)		300
6.	Storage: laundry & uniforms	100	
	ERU Crew Support Subtotal		880
	COMMUNICATIONS/OFFICES		
7.	Communications room	150	
	8. Day room & kitchenette	12	250
	9. Crew chief office		200
	Communications Subtotal		600
	GARAGE		
	10. 4 Garage bays, including		
	2 emergency response vehicles (15' x 25')		750
	1 all purpose vehicle (12' x 25')		300
	1 trailer-mounted arrow board (12' x 25')		300
	11. Workbench area (12'x 14')		150
	12. Firefighting & first aid equip-ment storage (2 - 10'x20' each)		400
	Garage Subtotal		1,900
	BUILDING SUPPORT		
	13. Janitor		70
	14. Mechanical/Electrical Room		400
	15. Service/Delivery entry		200
	Building Support Subtotal		670
	N.S.F. Total		4,430
	X 1.25 Net to Gross Factor		
	G.S.F. Total		5,537

TABLE: 7.4 SITE PROGRAM

	1. Parking for 4 cars: 2 staff,		
	2 police cruisers (350/car)		1,400
	2. Disabled vehicle storage for:		
	2 tractor/trailers		700
	2 cars (20' x 50' each)		2,000
	3. Maneuvering Area		2,500
Total Site Square Feet		6,600	

7.4.2.3 Specific Program Requirements

1. Building image should inform motorists of its function and inspire confidence and respect. The building aesthetic should be in keeping with urban fabric in terms of building massing, orientation, and facades.

2. Emergency response areas are not open to the public, but public assistance facilities are to be provided in conjunction with these functions. Members of the public who are being assisted due to disabled vehicles must be able to enter building, have access to telephones and toilets, and be able to wait in a safe, heated place for a tow truck to come and get their vehicle. Visual access to disabled vehicles by members of the public is desirable. these functions must not compromise the security of the emergency response and operations control functions.

3. Lockers to be provided for each emergency station crew member, 50%/50% male/female distribution.

4. First aid supply closet to be provided in crew chief office for security. Small first aid treatment space to be adjacent and near lockers/showers.

5. Garage floors must be sloped to drain with oil/grease trap. Garage must be ventilated to prevent movement of vehicle exhaust air to inhabited spaces.

6. Habitable spaces to be air-conditioned, garage air to be tempered.

7. CCTV (Closed Circuit TV) surveillance of doors, access and security control at all times. Separate public access areas from rest of facility.

8. Provide emergency station with efficient access to I-93 tunnel.

9. Locate disabled vehicle storage in close proximity to emergency station; provide visual access from public assistance area if possible. Provide secure enclosure for disabled vehicles.

10. Provide maximum of 62' turning radius circulation into disabled vehicle parking lot for tractor-trailers hoisted on an emergency response vehicle tow truck. Provide 12' turning radii for short wheel base emergency vehicles elsewhere on site.

7.4.2.4 Design Guidelines

1. The primary material for Emergency Station No. 7 should be brick, in keeping with the character of both nearby Canal Street and the existing electricity substation on the site that will be retained.

2. The building should be designed to enclose the site at its edges, ie., to be built up to the sidewalk to anchor the street lines rather than being set back from the corner.

3. Of all the site boundaries, only the Canal Street side is active and heavily used by pedestrians. For this reason, the corner of Canal and New Chardon Street will be left open for future development which will be more supportive of pedestrians than the Emergency Station. Special attention should be given to a detailing of this elevation of future development which is consistent with and enhances existing Canal Street uses.

4. Design should reinforce project-wide architectural imagery, drawing particularly on detailing and image of Vent Building 4 nearby.

5. Building should be two stories in height with a flat roof.

7.4.2.5 Summary of Materials and Finishes

1. Interior Finishes: In garage area, walls and partitions to be painted reinforced concrete block. Floors to be concrete with dust eliminating treatment or sealer. Ceilings to be painted exposed structural system for garage areas. Painted GWB walls, resiliant flooring, suspended acoustic ceiling for habitable areas.

2. Exterior Materials: Brick, metal fascia, metal roof or flat EPDM roofing.

7.4.2.6 Building Code Requirements

1. Use Group Classification: S-1 Storage Building Moderate Hazard.

2. Construction classification: Type 2C, unprotected. Non-combustible construction.

7.5 LANDSCAPE ARCHITECTURE

7.5.1 INTRODUCTION

The scope of Landscape Architecture in this Section Design Contract includes design for two time periods:

a. Construction period mitigation and pedestrian protection;

b. Site improvements as an interim final scheme:

o Temporary landscape development related to the highway architectural elements occurring at the surface which include ramps, portals, boat section retaining walls, and tunnel headhouses;

- Backfill, grading, seeding, and loam will comprise the temporary condition in which the surface is left at the completion of the D015A contract. In addition, temporary asphalt curbs, sidewalks, and open paved pedestrian zones will be provided for pedestrian circulation. A continuous jersey barrier and 5'0" gravel strip will run along each parcel parallel to the corridor parcel surface. Refer to detail AR8-PD-L-052. Temporary lighting in accordance with City of Boston Design Standards will also be provided along the surface road corridor and pedestrian cross-street sidewalks. Portal Park and the open area adjacent to Ventilation Building No. 4 are considered as permanent and final design treatment areas rather than as site improvement areas. For landscape design layouts for these areas, refer to drawing for Portal Park and drawing AR8-PD-L-051 for Ventilation Building No. 4.

7.5.2 HIGH PRIORITY PEDESTRIAN CROSSING ZONES

Pedestrian and handicapped access is to be maintained as close to its existing location as possible with interruption to be minimized throughout the construction area and time period. Access to existing businesses, residences, and historic attractions is seen as the highest priority, particularly for tourists who may have difficulty finding their way.

7.5.3 CONSTRUCTION PERIOD PEDESTRIAN PROTECTION

The provision of a safe, well-lit and clean pedestrian environment maintained throughout construction period is seen as a high priority. The negative effects of construction activity, will be mitigated by providing continuous, direct, and protected pedestrian walkways and crossings throughout the contract limits.

CA/THT pedestrian environments will be protected by construction site perimeter fencing, barriers, and signage which is to be designed as part of a modular system, made up of consistent materials, colors, proportions, and graphics. For Construction Period "Kit-of-Parts" treatment refer to Section 7.3.5 and Standard Drawings SD-H-401, 402, 403. Special long-term construction period urban space development is proposed at selected locations to form gateways for major pedestrian crossings, entry points, and sites for construction period art installations. For locations of these special gateways, see Mitigation Drawing above. In addition, entry points will be furnished with moveable planters, trash barrels, and crossing beacons to provide additional focus and pedestrian orientation.

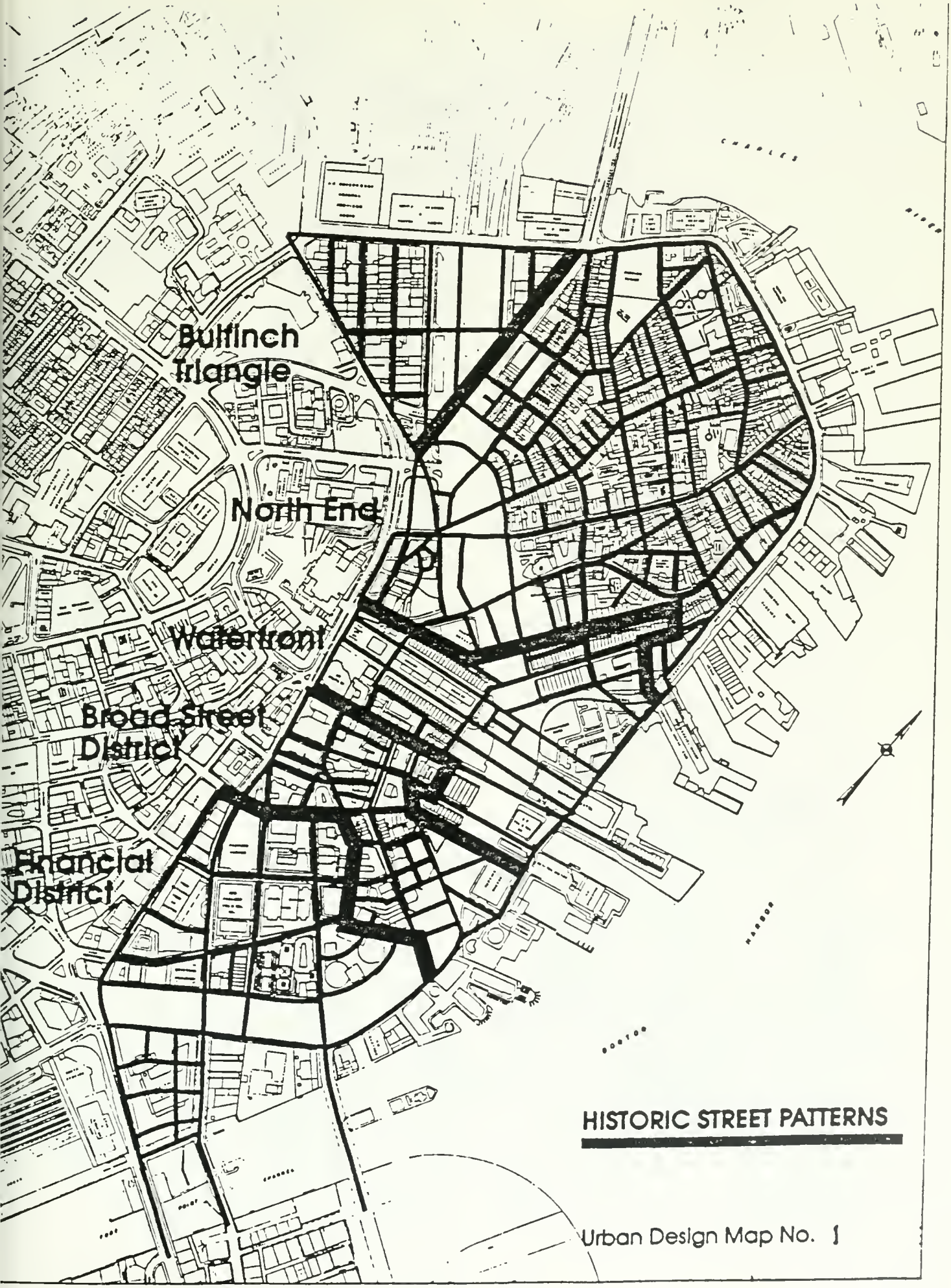
Construction period furnishings and pedestrian environment enhancement will promote a positive human image of the project, provide enough exposure of how construction proceeds and encourage

public patience with construction period inconvenience simultaneously protecting pedestrians, and earning the public's patience while encouraging their interest in the many stages of the construction process itself.

7.5.4 PLANT MATERIAL

Plant materials will be deciduous trees in moveable planters, species suggested include;

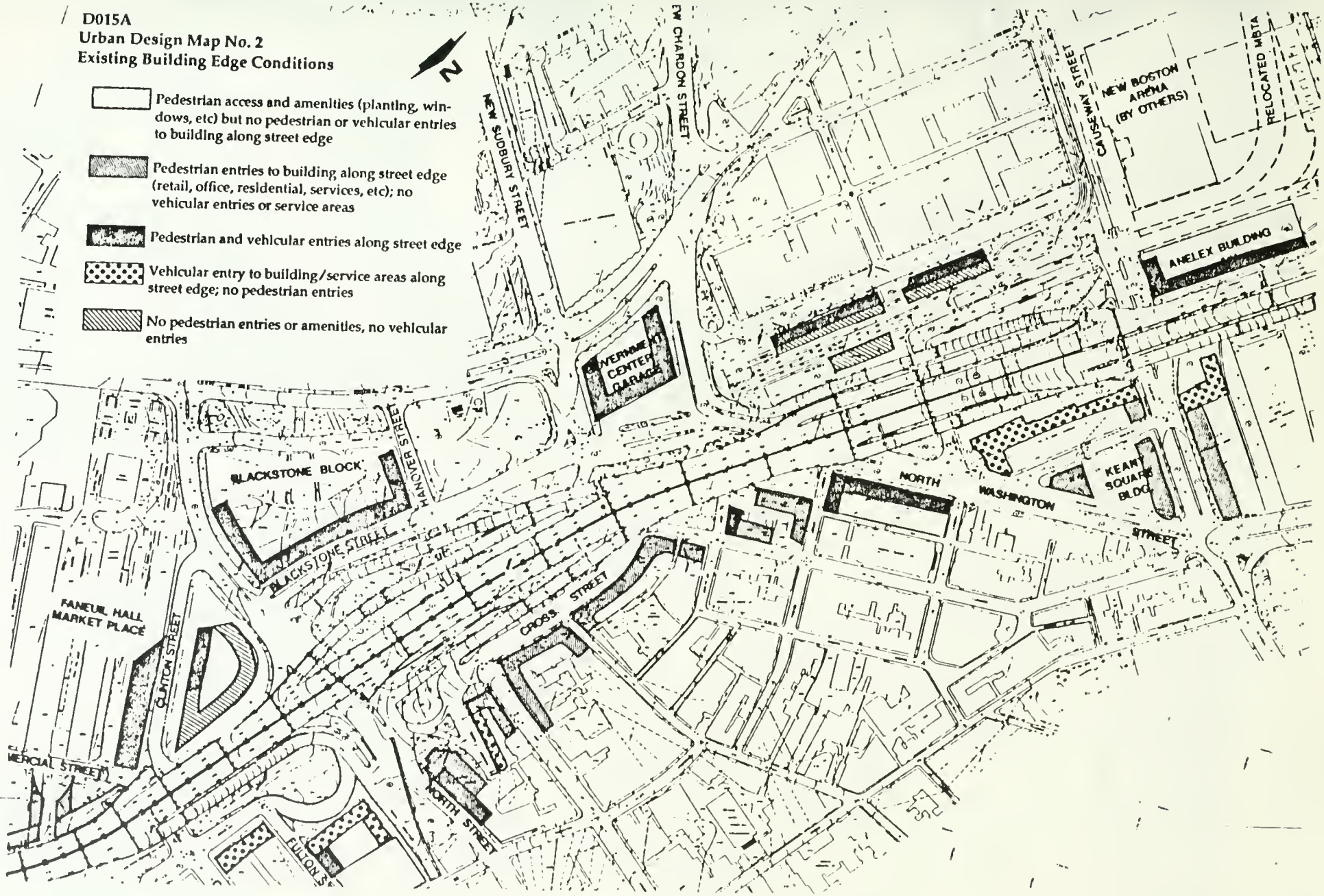
- Tilia cordata - Littleleaf Linden
- Gleditsia Triancanthos Inermis - Thornless Honeylocust
- Acer Platanoides - Condon Plane Tree

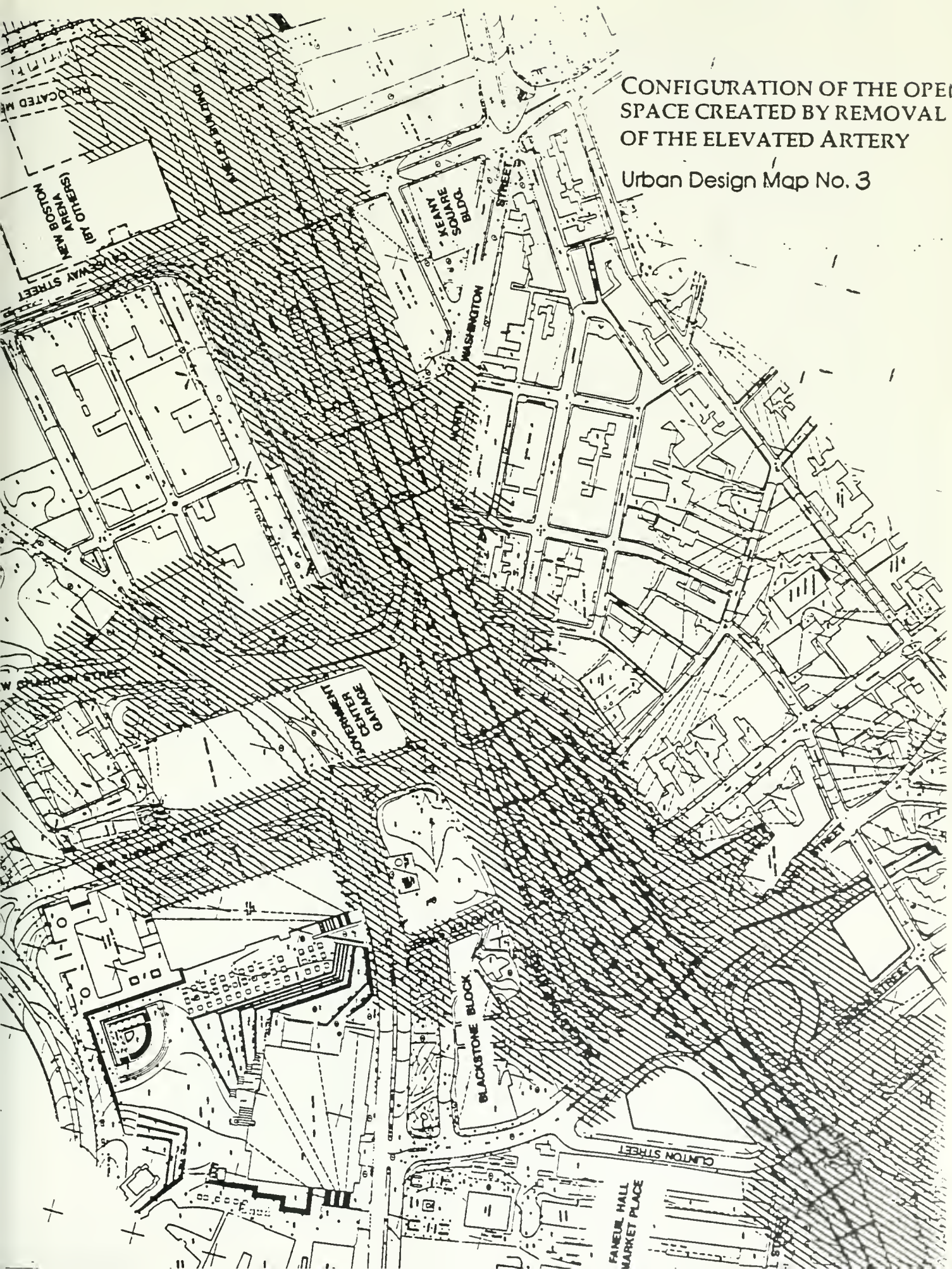


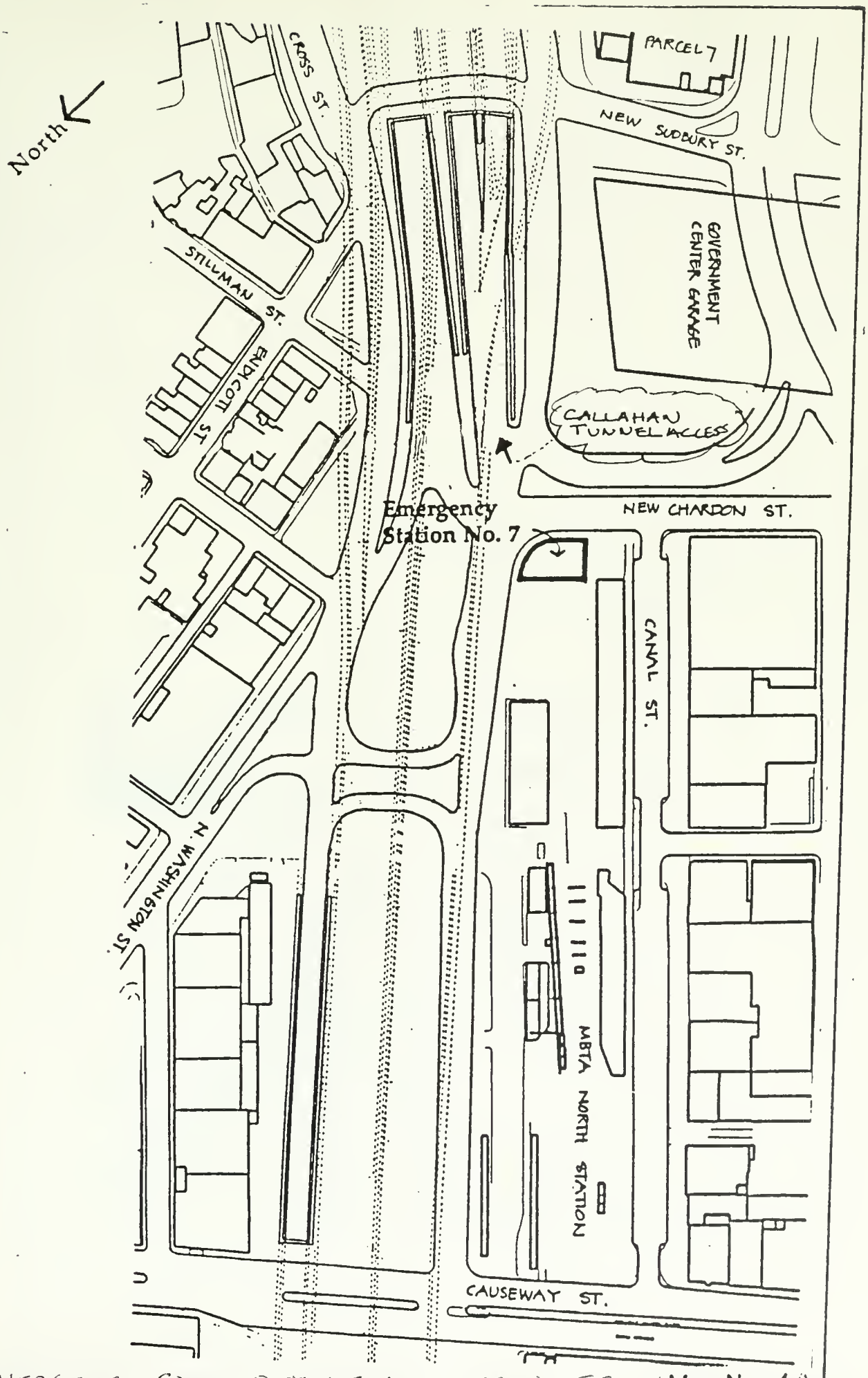
HISTORIC STREET PATTERNS

Urban Design Map No. 1

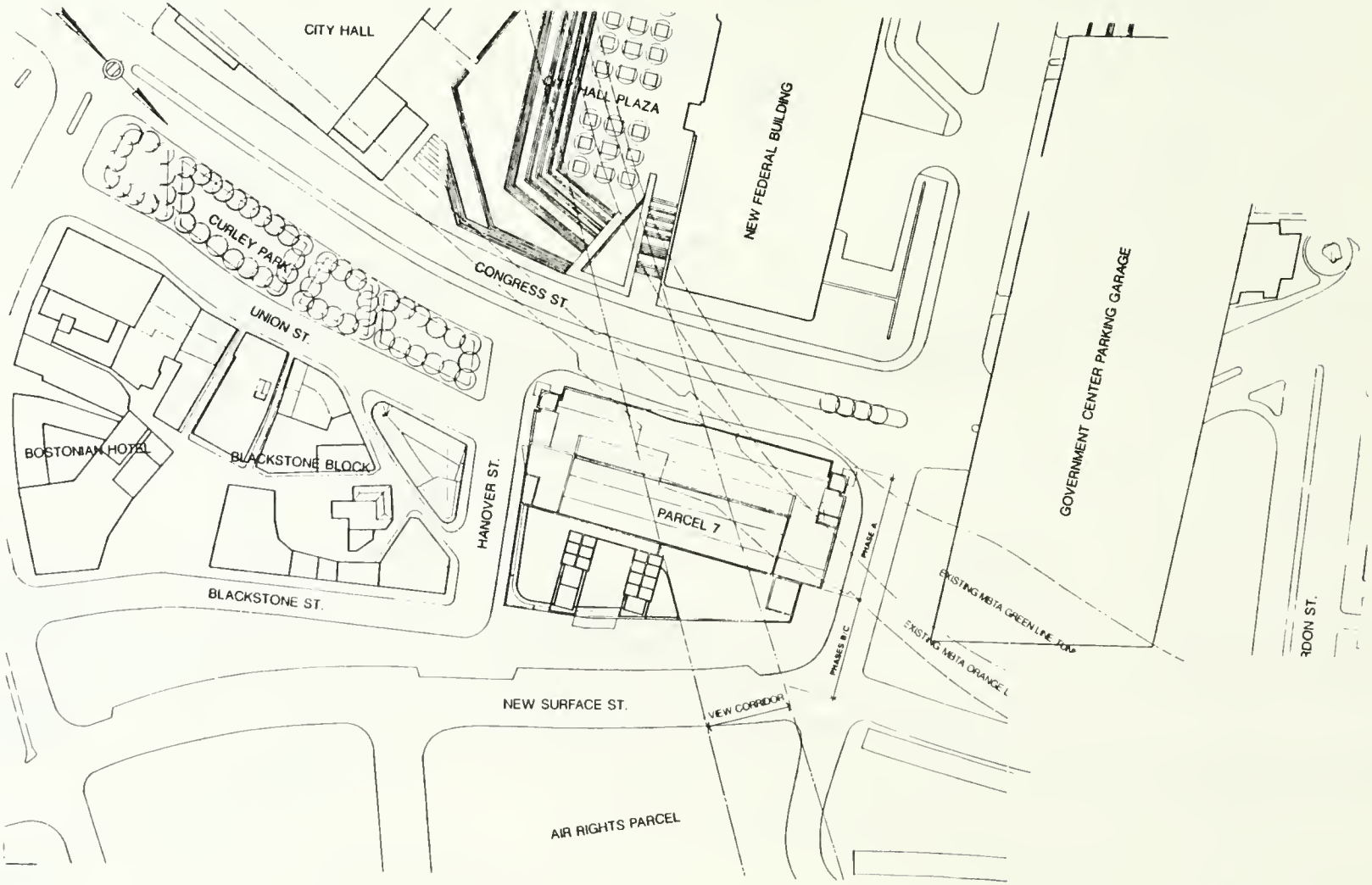
D015A
Urban Design Map No. 2
Existing Building Edge Conditions


N
Pedestrian access and amenities (planting, windows, etc) but no pedestrian or vehicular entries to building along street edge
Pedestrian entries to building along street edge (retail, office, residential, services, etc); no vehicular entries or service areas
Pedestrian and vehicular entries along street edge
Vehicular entry to building/service areas along street edge; no pedestrian entries
No pedestrian entries or amenities, no vehicular entries
NEW SUDBURY STREET
CHARDON STREET
CAUSEWAY STREET
NEW BOSTON ARENA (BY OTHERS)
RELOCATED MBTA
AMELEX BUILDING
GOVERNMENT CENTER GARAGE
BLACKSTONE BLOCK
HANOVER STREET
BLACKSTONE STREET
NORTH
WASHINGTON
STREET
KEARNY SQUARE BLDG.
FANEUIL HALL MARKET PLACE
CLINTON STREET
CROSS
STREET
NORTH STREET
FULTON ST.
MERCIAL STREET


CONFIGURATION OF THE OPEN SPACE CREATED BY REMOVAL OF THE ELEVATED ARTERY
Urban Design Map No. 3
KEANY SQUARE BLDG.
WASHINGTON STREET
NORTH
NEW BOSTON GARDEN (BY OTHERS)
CAUSEWAY STREET
GOVERNMENT CENTER GARAGE
BLACKSTONE BLOCK
CLINTON STREET
FANEUIL HALL MARKET PLACE



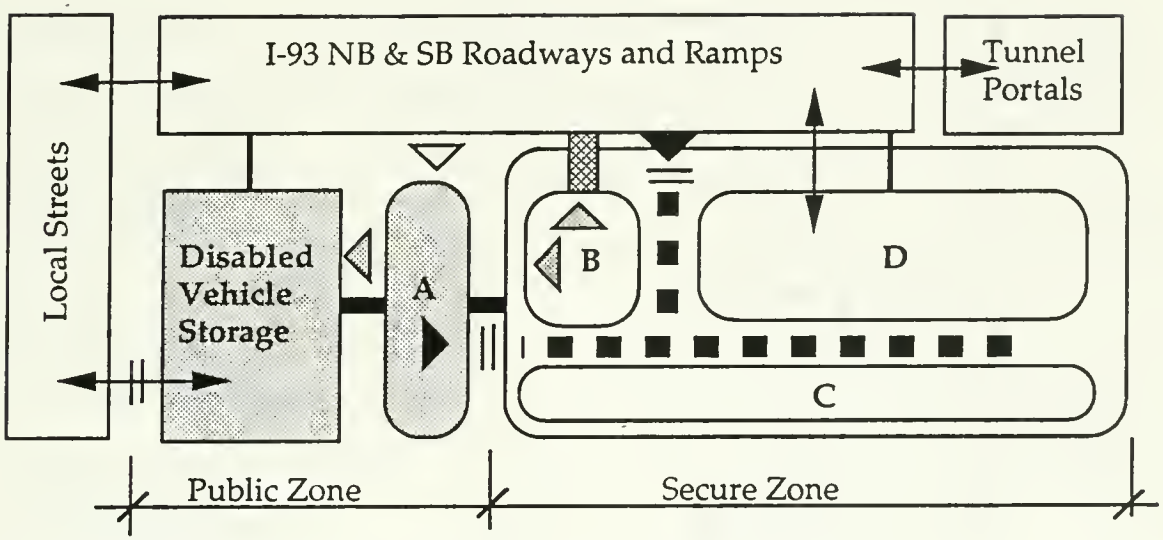
EMERGENCY STATION TUNNEL ACCESS-URBAN DESIGN Map No. 4A



Urban Design Map No. 4: Site Location Parcel 7

Urban Design Map No 5. Site Plan Emergency Station 7

Figure 1. Spatial and Site Program Relationships



A Public Access Area
B Communications and Emergency Crew Chief
C ERU Crew Support
D Garge Bays

DIAGRAM KEY

Building program element.....
Public access.....
Direct vehicle access.....
Communications access.....
Mandatory adjacency.....
Security control point.....

Site program element .....
Public access areas.....
Visual access.....
Staff access.....
Recommended adjacency.....
Major building circulation.....

Figure 2. Room Relationships Diagram

REFERENCE KEY

PUBLIC ACCESS AREAS
1 Public Street Entry
2 Public waiting area
3 Public toilets
4 Kiosk/vehicle storage

ERU CREW SUPPORT
5 Lockers and showers (M & F)
6 Staff toilets (M & F)
7 Laundry/uniform storage

COMMUNICATIONS/OFFICES
8 Communications Room
9 Day room/kitchenette
10 Crew Chief office

GARAGE
11 4 Vehicle Bays
12 Workbench area
13 Emergency equipment storage

BUILDING SUPPORT
14 Janitor
15 Mechanical/Electrical room
16 Service/Delivery entry

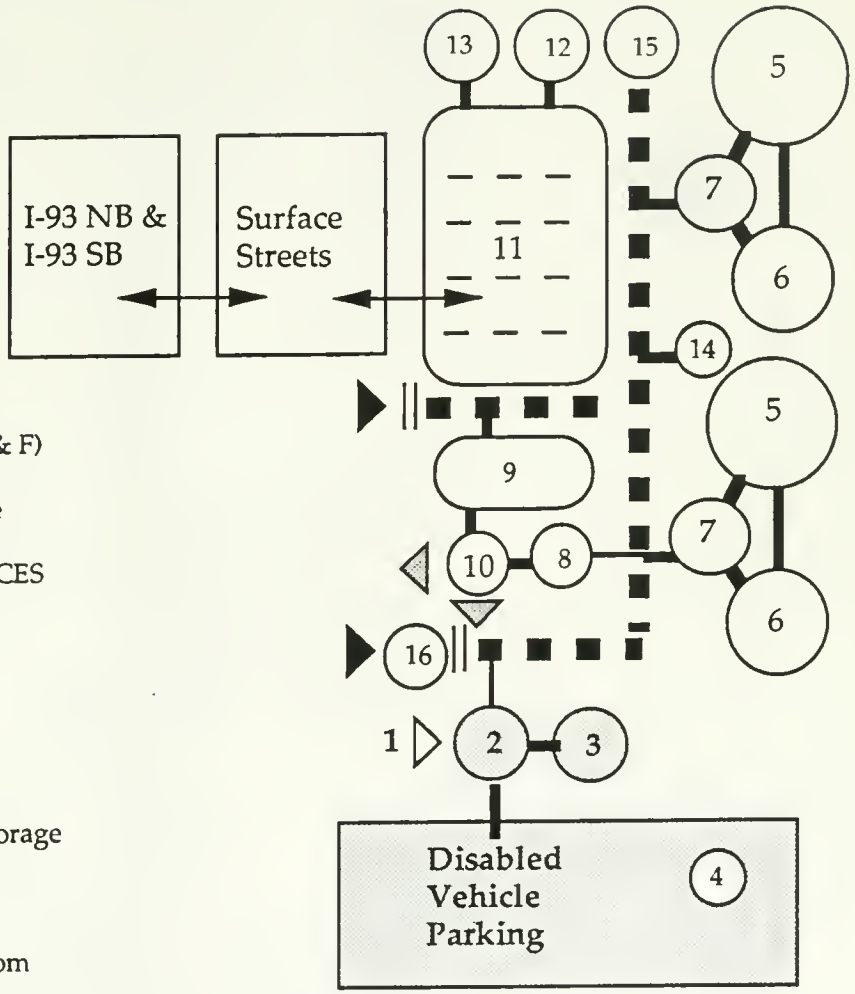


DIAGRAM KEY

Building program element.....

Public access.....

Direct vehicle access.....

Communications access.....

Mandatory adjacency.....

Security control point.....

Site program element .....

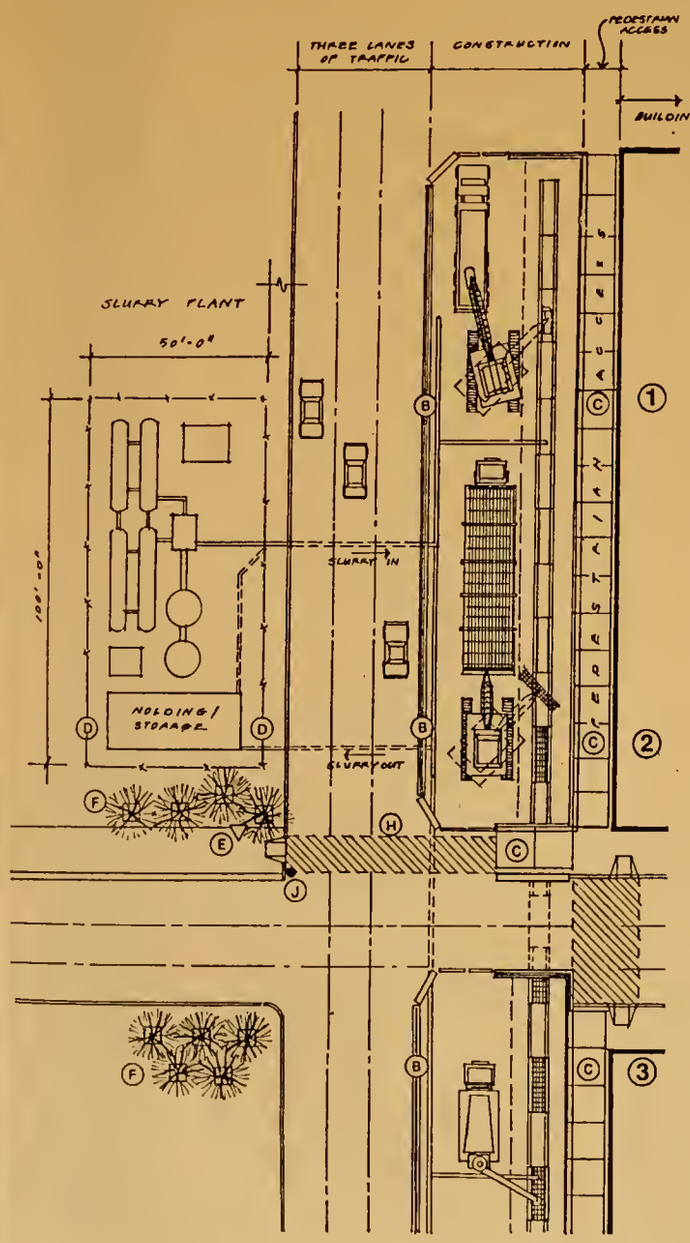
Public access areas.....

Visual access.....

Staff access.....

Recommended adjacency.....

Major building circulation.....



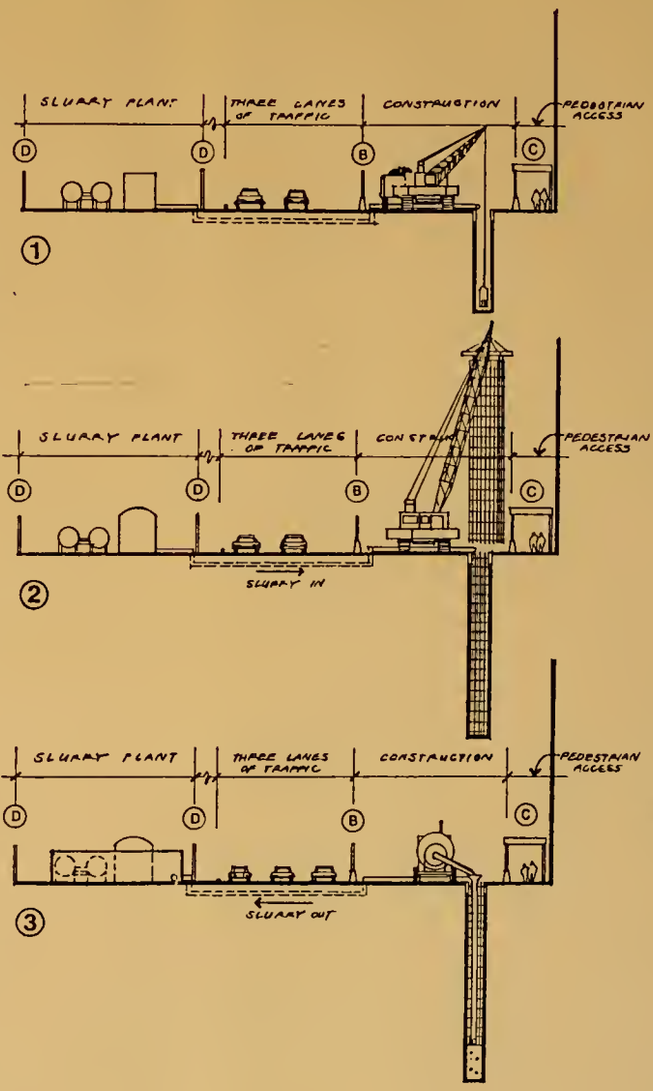
The construction zone, 36' to 40' wide, will be separated from public access by a continuous concrete barrier broken only by removable wooden barriers used for construction vehicle ingress and egress. When required for public safety, construction operation protection or dust and debris containment, a 6'-10' high fence will be affixed to the concrete barrier. Safe pedestrian access and three lanes of moving vehicular traffic (in each direction, north and south) will be maintained throughout all of the construction stages. Pedestrian and/or vehicular crossings through construction zones (east and west, perpendicular to Central Artery corridor) will be provided within designated zones.

The proposed slurry wall location will be surveyed and staked. Guide walls will be placed on either side of the proposed slurry wall alignment. A crane equipped with a clam shell bucket will excavate alternating sections, approximately 15' long, between the guide walls. Materials from the 50'-100' deep trench will be loaded onto dump trucks and carried to the barge loading facility, treatment plant or land fill site.

Bentonite slurry, piped from an on-site slurry plant, will fill the trenches and stabilize the trench walls. Steel reinforcing cages will be lifted and placed into the slurry-filled trench by a crane.

Concrete, delivered to the site in transit mixer trucks, will be placed into the bottom of the trench by use of a hopper and tremie pipe. As the concrete fills the trench, the bentonite slurry will be displaced and will be pumped back to the slurry plant where it will be held in storage and reprocessed for future use. As the concrete-filled trenches cure, the entire process will be repeated for the alternating 15' sections between the completed concrete wall sections. For the length of one city block, approximately 250 feet, and assuming a 100 foot depth, a duration of 5-6 weeks should be expected for completion of one continuous slurry wall.

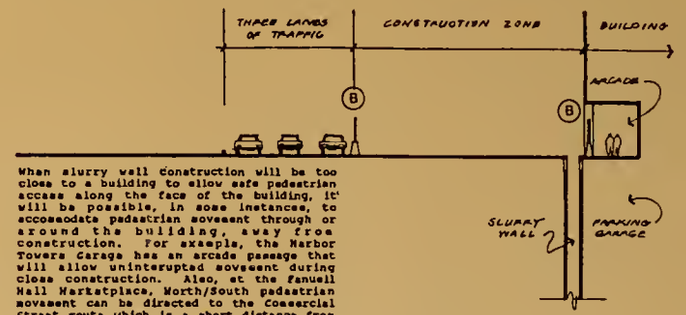
SLURRY WALL CONSTRUCTION
PROTOTYPICAL CONDITIONS/PLAN



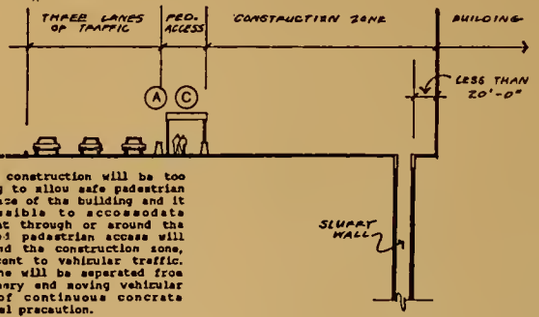
SLURRY WALL CONSTRUCTION
PROTOTYPICAL CONDITIONS/SECTION

KEY: KIT-OF-PARTS

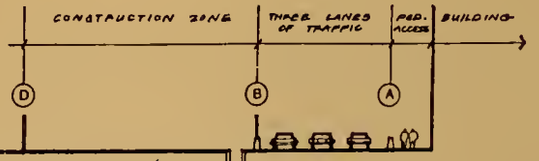
(A)	CONCRETE TRAFFIC BARRIER	
(B)	CONSTRUCTION BARRIER	DETAIL 7 80-H-403
(C)	PEDESTRIAN COVERED WALKWAY	DETAIL 1 80-H-402
(D)	CONSTRUCTION FENCE	DETAIL 4 80-H-403
(E)	INFORMATION/DIRECTION KIOSK	DETAIL 5 80-H-403
(F)	FIBERGLASS PLANTER	DETAIL 1 80-H-403
(G)	GATEWAY STRUCTURE	DETAIL 6 80-H-403
(H)	SAFETY STRIPING	
(J)	CROSSING BEACON	DETAIL 3 80-H-403



When slurry wall construction will be too close to a building to allow safe pedestrian access along the face of the building, it will be possible, in some instances, to accomodate pedestrian movement through or around the building, away from construction. For example, the Harbor Towers Garage has an arcade passage that will allow uninterupted movement during close construction. Also, at the Faneuil Hall Marketplace, North/South pedestrian movement can be directed to the Commercial Street route which is a short distance from the parallel Surface Road access, interupted by construction.



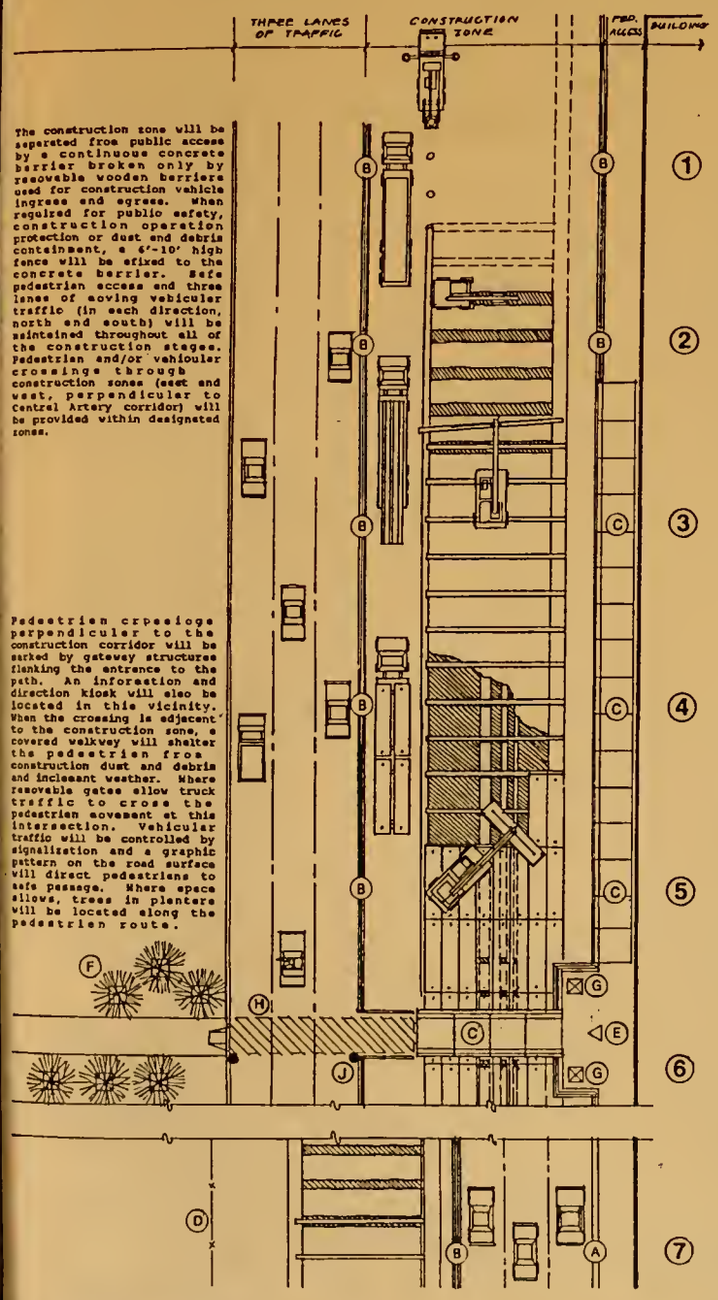
When slurry wall construction will be too close to a building to allow safe pedestrian access along the face of the building and it will not be possible to accomodate pedestrian movement through or around the building, protected pedestrian access will be provided around the construction zone, parallel and adjacent to vehicular traffic. This pedestrian zone will be separated from construction machinery and moving vehicular traffic by use of continuous concrete barriers as a minimal precaution.



Where slurry wall construction will be far enough removed from the face of a building to allow safe pedestrian access along the face of the building, the pedestrian zone will be separated from construction activities by a concrete barrier and/or protective fencing. When moving traffic will be adjacent to the pedestrian access and a curb no longer exists as a separation, a concrete barrier will be used to distinguish the pedestrian zone from the vehicular.

SLURRY WALL CONSTRUCTION
SPECIAL CONDITIONS/ SECTIONS

Mitigation Drawing 1: Slurry Wall Construction



The construction zone will be segerated froe public access by a continuous concrete barrier broken only by resovable wooden barriers used for construction vehicle ingress and egress. When required for public safety, construction operation protection or dust and debris containment, a 6'-10' high fence will be afixed to the concrete barrier. Safe pedestrian access and three lanes of moving vehicular traffic (in each direction, north and south) will be maintained throughout all of the construction stages. Pedestrian and/or vehicular crossings through construction zones (east and west, perpendicular to central Artery corridor) will be provided within designated zones.

Pedestrian crossings perpendicular to the construction corridor will be marked by gateway structures flanking the entrence to the path. An information and direction kiosk will also be located in this vicinity. When the crossing is adjacent to the construction zone, a covered walkway will shelter the pedestrian froa construction dust and debris and inclesant weather. Where resovable gates allow truck traffic to cross the pedestrian aovement at this intersection. Vehicular traffic will be controlled by signalization and a graphic pattern on the road surface will direct pedestrians to safe passage. Where space allows, trees in planters will be located along the pedestrian route.

DECKING CONSTRUCTION
PROTOTYPICAL CONDITIONS/PLAN

① In order to shorten the base span between slurry walls, teaporary pins or post piles will be placed approximately 10' on center in a line parallel to the slurry walls. Holes for the pilings will be drilled to a depth agual to the slurry wall depth. After the pilings are placed, they will be connected by a base set on top of the pile.

② The area between the slurry wall and the pin or post pile bases will be dug out to receive the deck bases. A backhoe excavator will be used to remove the excavated saterial and load it into a dump truck, which will carry the saterials to the barge loading facility, treatment plant or land fill site.

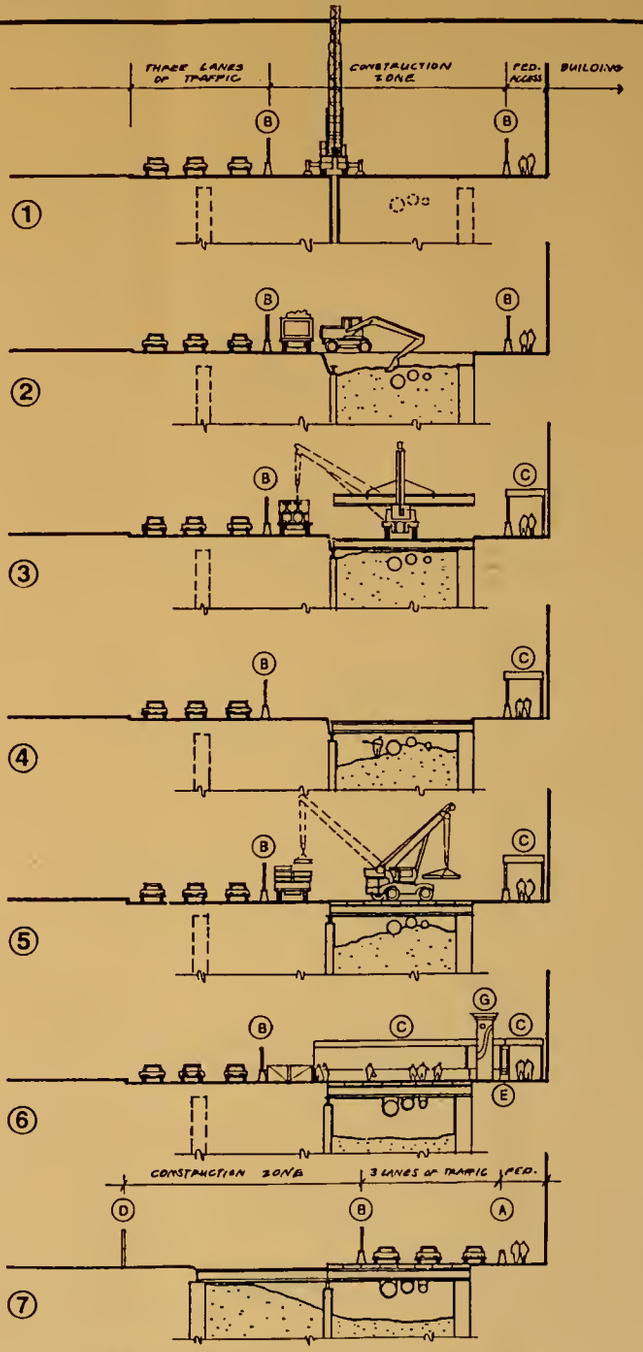
③ A crane will lift the deck bases fros the bed of the delivery truck and place thes to bear on the slurry wall and pin or post pile bases.

④ Further excavation between deck bases and around existing utilities will then be done. Because of the fragility of aany utility structures, much of the excavation will need to be done by hand. Utilities will remain in the location in which they are found. Some existing services aay be relocated to accomsodate excavation.

⑤ Planking panels (wood or concrete) prefabricated to specifications that accomsodate the span between the deck bases, will be lifted fros the delivery truck bed and put into place by a crane. Panels will be approximately 4'-0" wide, 10'-0" long and 12" thick.

⑥ Once the panels are in place, the utilities will be suspended fros the deck bases, still in their original locations, vertically and horizontally. Material beneath the utilities will then be carefully removed.

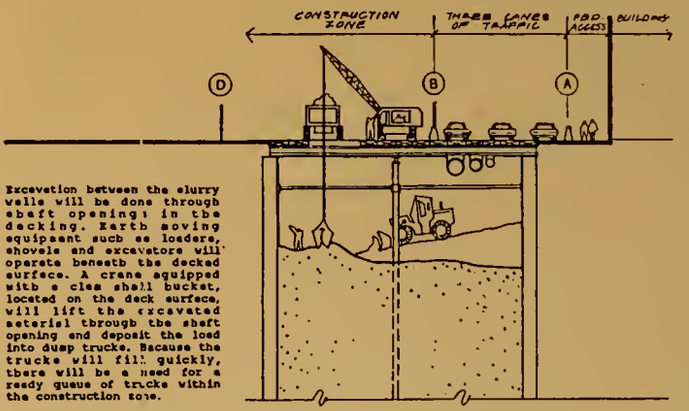
⑦ When the decking procedure has been completed, vehicular traffic can then move to the decked area. The entire procedure will then be repeated until the area between two slurry walls is completely covered and excavation can continue beneath the decking.



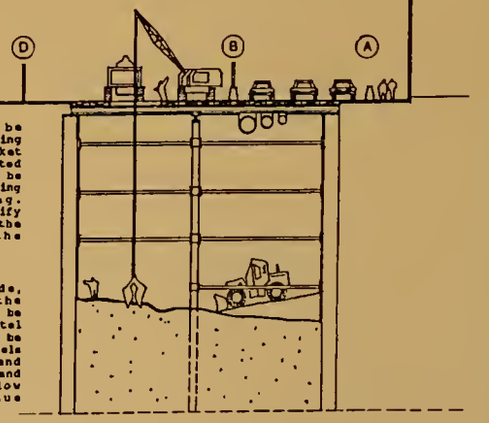
DECKING CONSTRUCTION
PROTOTYPICAL CONDITIONS/SECTION

KEY: KIT-OF-PARTS

(A)	CONCRETE TRAFFIC BARRIER	
(B)	CONSTRUCTION BARRIER	DETAIL 7 SD-H-403
(C)	PEDESTRIAN COVERED WALKWAY	DETAIL 1 SD-H-402
(D)	CONSTRUCTION FENCE	DETAIL 4 SD-H-403
(E)	INFORMATION/DIRECTION KIOSK	DETAIL 5 SD-H-403
(F)	FIBERGLASS PLANTER	DETAIL 1 SD-H-403
(G)	GATEWAY STRCTURE	DETAIL 6 SD-H-403
(H)	SAFETY STRIPING	
(J)	CROSSING BEACON	DETAIL 3 SD-H-403



Excavation between the slurry walls will be done through shaft openings in the decking. Earth moving equipment such as loaders, shovels and excavators will operate beneath the decked surface. A crane equipped with a clam shell bucket, located on the deck surface, will lift the excavated material through the shaft opening and deposit the load into dump trucks. Because the trucks will fill quickly, there will be a need for a ready queue of trucks within the construction zone.

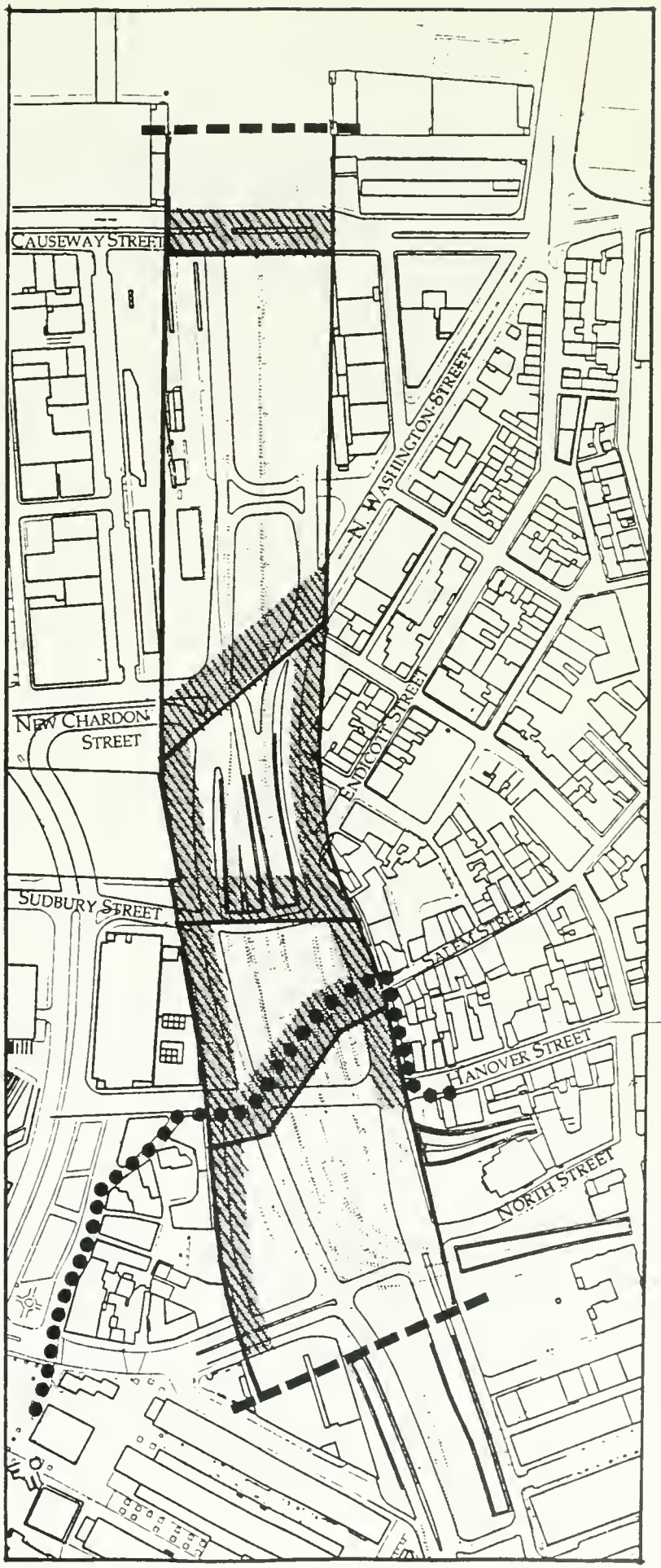


A signal person will be stationed beneath the decking in the area of the bucket contact with the excavated material and another will be stationed above the decking at the shaft opening. Together they will clarify communications between the crane operator and the excavator.

As excavation proceeds, lateral pressure on the slurry walls will need to be counteracted by horizontal bracing. This bracing will be placed at regular intervals throughout the length and depth of the excavation and its placement will allow excavation to continue unimpeded.

EXCAVATION PROCEDURE
PROTOTYPCAL CONDITIONS/SECTION

Mitigation Drawing 2: Decking Construction and Excavation



LEGEND

N

PEDESTRIAN ZONES TO BE MAINTAINED DURING CONSTRUCTION

NORTH AND SOUTH LIMITS OF D015A

THE FREEDOM TRAIL

Mitigation Drawing 3:

Pedestrian zones requiring mitigation

8.0 Storm Drainage

8.1 Boat Section Drainage

In general, the design of the storm drainage system for the CA/T project complies with BWSC's position concerning the connection of highway drainage (under MDPW control) with the BWSC collection system. In a few isolated locations, however, physical constraints make it infeasible to construct separate outfalls for the highway drainage. The locations consist of ramps connecting the Central Artery tunnel with the surface streets and the Sumner and Callahan Tunnels. The ramps are narrow, short "boat" sections of roadway which will contribute insignificant peak discharges to any individual existing outfall. The peak 10-yr return period discharge from the ramps to any single outfall to be owned by the city will be less than 5 cfs.

Currently, the project is proposing to discharge storm drainage from 2 MDPW owned pump stations into storm drains to be owned by the city. The locations of these pump stations are the proposed vent building at Blackstone Street and the portals near the Callahan and Sumner Tunnels. Another MDPW owned pump station located at the Causeway Street portals will discharge directly to the Harbor.

8.2 Surface Street Drainage

Unusual features that the SDC should be aware of during the final design in some instances are where the tunnel roof structure is in close proximity to the surface street grades.

In the vicinity of Cross Street and Hanover Street, surface inlets on the southerly side of the intersection encroach on the tunnel roof of Ramp ST-CN leading from the Sumner Tunnel.

In addition, drainage of the infield area adjacent to the New Sudbury Street crossover will require lateral drainage piping to be installed in conjunction with the tunnel roof concrete of ramp ST-SA. The lateral will be supported between the roof beams and exit through the slurry wall.

The inlets on either side of ramp ST-SA will be catch basins with sumps.

The storm drain leg connecting with the main line at storm drain Station 11+96 at Valenti Way and running northerly on the west side surface artery will be located just outside the tunnel concrete of the CASB. However, the drain inlets on the easterly gutter line will encroach on the tunnel concrete roof and should be constructed with the tunnel concrete roof. Lateral drainage piping and fittings will be supported between roof beams. The pipe material used will be flanged ductile iron.

Inlets picking up infield runoff on the easterly side of the

infield area will also encroach on the tunnel concrete and should be constructed similiarly as described above. However, the northbound surface street is adjacent to the east side slurry wall of the northbound roadway tunnel therefore no special conditions exist.

The remainder of the drainage system may be constructed during the final phase of construction.

9.0 Utility Relocations

9.1 Early Utility Relocation Corridors

Early utility relocation corridors were designed and constructed with the intention that the transverse utility crossing and longitudinal utility corridors within slurry walls will be protected and supported during C15A construction activities.

Undercarriage steel and pipe joint clamps for reinforced concrete pipe have been included with early relocated utilities within transverse and inside longitudal corridors in anticipation of the proposed utility support system to be constructed as part of this contract.

The utility support system shall be designed to avoid any settlement, minimize any vibration being transferred to the utilities, and consider all resultant and expansive forces generated from pressurized systems.

Refer to Section 5.0 for the structural requirements of the Utility Support System.

Provision also should be made to:

- Provide personnel protection for electrical conduits and manholes
- Adequately protect all utilities during construction
- Provide freeze protection to all susceptible utilities
- Maintain waterproofing to all electrical and communication conduits and appurtenances. Electric, telephone and other communication conduits have not been concrete encased within transverse crossing inorder to minimize dead loads.
- Maintain access to all manholes and valving

Upon completion of the mainline tunnel construction, and during the backfilling process, all utilities are to be properly reset upon properly compacted backfill material.

Due to the difficulty of properly compacting backfill under utilities, and the removal of undercarriage steel without disrupting the utility, a lean concrete cradle is to be considered between the utility and the properly compacted backfill.

This concrete cradle is to be poured around the undercarriage steel. When the concrete has cured, the tie rod supports can be removed.

Also, electrical, telephone and all other communication

conduits are to be concrete encased in accordance to owners specifications, and allowed to cure before backfilling.

9.2 New Utility Corridors

New utility corridors are divided into two categories, 1. utility corridors designed and constructed under Contract D015A and 2. Utility corridors designed under design Contract D014B and constructed under C15A.

9.2.1 Utility Corridors Designed and Constructed Under Design Contract D015A are:

- Accolon Way
- Cross St., Sumner Tunnel and Callahan Tunnel crossing Accolon Way

The Final Design Drawings for the extension of LS 36" water line and T (12-4") telephone conduit from Causeway St, northerly along the new ramp for the Boston Gardens back to existing located near the Charles River.

The design and construction will require close coordination with the adjacent MBTA Parking Garage and Green Line Relocation Project and the new Boston Garden construction projects.

The LS 36" water line is to be located with a seven foot wide corridor between the outside of the State Highway location line, (SHLL) and the new MBTA Garage Ramp.

Cross Street at, Sumner and Callahan Tunnel Crossing

The Final Design Drawings for the relocation of CS 66", LS 12", HF 16", HS 24, and two E(9-5") from the intersection of Cross and Hanover St, across Sumner Tunnel and Callahan Tunnel to Cross St. in the vicinity of the existing Callahan Tunnel off ramp.

This areas will require close cooperation with the Massachusetts Turnpike Authority in regards to pending tunnel renovations and of traffic maintenance.

9.2.2 Utility Corridors Designed Under Design Contract D014B and Constructed Under C15A are:

- Valenti Way
- Cross St. at Enicott St. extension

Valenti Way

The relocation of the Valenti Way combined sewer is the principal problem in this area . The crossing is proposed at approximately Northbound Station 158 + 00 to avoid the existing

utilities in Valenti Way as well as the structural elements of the existing Artery.

The existing sewer on Valenti Way consists of 66-inch, 102-inch, and 30-inch x 36-inch sections. The proposed replacement is a twin 48-inch relocation.

An existing MDPW steam pump house (originally intended for keeping ramp pavements clear of snow and ice), electrical substation and transformer vault (also used for roadway lighting) must be removed to complete the work in this area. The retained fill of the Southbound off-ramp to New Chardon Street must be removed to facilitate completion of the proposed CS 2-48". The D014B SDC will prepare engineering drawings for the entire combined sewer relocation suitable to be included in two separate construction contracts.

Construction Contract C14B1

The relocation will be constructed from a new manhole structure at the corner of Valenti Way and North Washington street to a temporary junction box connecting to the existing CS 102".

Construction Contract C15A2

After relocation of the existing retained fill off-ramp, the proposed CS 2-48" relocation will be completed and a permanent connection made to a reconstructed Valenti Way siphon manhole structure. The last stretch of pipe (CS 2-60") will replace the pipes rising from the reconstructed inverted siphon.

Cross Street at Endicott Street Extension

The connections between the New Sudbury transverse relocation and Cross Street will be designed in two parts, by the D014B Section Design Consultant (SDC), as described below:

Construction Contract C14B1

There will be no portion of slurry wall constructed in C14B1 at Cross Street, since in this construction contract, the new lines will be connected to existing lines westerly (or inside) of the future Artery wall. The D014B SDC must work out the horizontal and vertical requirements of these temporary connections, including any temporary manholes required. The 66-inch combined sewer will be connected, similarly, to the existing 57 x 60 - inch sewer.

Construction Contract C15A1

The earlier temporary connections of C14B1 will be altered as necessary, and the new relocations extended to connect to existing lines in Cross Street. The D014B SDC will prepare the necessary engineering drawings for the relocation extensions to be included

in the C15A1 construction contract which will be prepared by the D015A SDC. The purpose of this arrangement is to minimize construction disruptions in this area.

9.3 Minor Utilities and Service Connections

This contract will be responsible to design, support and protect all minor utilities and service connections slated to remain in service during and after construction.

Final design drawings shall incorporate all smaller utilities and service connections designated to be relocated, replaced or eliminated and a sequencing of events in order to minimize disruption of service.

Public and private agencies that may have utility services within the construction area, which will need protection from damage and, if necessary, temporary or permanent relocations, are:

- Massachusetts Department of Public Works
- Massachusetts Water Resources Authority
- Metropolitan District Commission
- City of Boston (Police, Fire, Transportation, and Lighting Departments)
- Boston Thermal Corporation
- Western Union
- Sprint
- MCI
- McCourt
- Teleport
- Cablevision of Boston

Design effort shall also include all temporary facilities required to insure pedestrian safety and to maintain vehicular traffic flow.

Street lighting and other exterior lighting becomes an important safety issue during construction, and should remain in service as long as possible or be relocated. Traffic signalling, temporary or permanant, shall be coordinated with MDPW, Boston traffic and other involved agencies in conjunction with Section 6.0.

10.0 MECHANICAL SYSTEMS

10.1 General

Final design of mechanical systems such as HVAC, fire protection, plumbing and drainage which are necessary to support Ventilation Building No. 4 and the planned commercial building above it shall be performed by the I-93 Central Artery Causeway to North Section Design Consultant in accordance with the Directive and Standard Drawings, Project Design Criteria and Standard Special Provisions.

Final design of mechanical systems such as HVAC, fire protection, plumbing and drainage which are necessary to support Emergency Station 7 shall be performed by the I-93 Central Artery Causeway to North Section Design Consultant in accordance with the Directive and Standard Drawings, Project Design Criteria and Standard Special Provisions.

The I-93 Central Artery Causeway to North Section Design Consultant will also be required to incorporate into the design, certain systemwide mechanical elements to be designed by the I-93 Mechanical/Electrical Systems(D020B) Section Design Consultant which generally include embedded piping, fire standpipes, the structural formation of the tunnel ventilation air ducts, transitions, flues, ports, damper openings and fan spaces.

Directive Drawings have been prepared to identify how these systemwide mechanical elements integrate with the structural design of the tunnel sections and the ventilation building. Preliminary engineering has been performed to establish approximate equipment sizes, duct dimensions, flue and port quantities and spacing, pipe sizes, drainage requirements and to functionally coordinate and facilitate the arrangement and orientation of these elements with other systemwide elements and structural requirements.

The I-93 Mechanical/Electrical Systems Section Design Consultant (Contract D020B) will be responsible for establishing the final design requirements for the tunnel ventilation, tunnel drainage and roadway fire protection systems including those elements requiring incorporation within the tunnel sections and ventilation building structural design. The I-93 Mechanical/Electrical Systems Section Design Consultant will also provide Directive Drawing verification, technical guidance and general coordination of these elements which affect the design work of the I-93 Central Artery Causeway to North Section Design Consultant.

10.2 Tunnel Ventilation

Ventilation within the I-93 Central Artery tunnels between State and Causeway Streets and their associated ramps will be provided as part of a multi-zone full transverse ventilation

system. Ventilation Building No. 4 will house the fourteen exhaust and ten supply fans which are required to provide the necessary amounts of supply and exhaust air to these tunnel sections and associated ramps.

With this type of ventilation system, fresh air is supplied via continuous ducts located beneath each mainline tunnel roadway. These ducts will be formed as part of the tunnel structure. The fresh air is delivered at curb level, along both sides of the roadway, through a series of embedded flues placed at predetermined intervals for the entire length of the tunnel. Exhaust air is collected through ports in the ceiling and transported back to the ventilation buildings via a continuous duct which is formed above each mainline roadway between the underside of the tunnel roof slab and the finished ceiling. The location and positioning of a number of the associated ramps will require side ducting of the supply and exhaust ducts.

Preliminary engineering has been performed to estimate the minimum duct cross-sectional area required for exhaust and supply air so as not to exceed the maximum allowable air velocities in the ducts. Since lower velocities are preferable, the design of the exhaust air ducts shall make maximum utilization of the available space above and below the roadways by providing as large a cross-sectional duct area as is physically possible within the structure. Due to varying widths of the tunnel roadways and the need to dispense supply air from each walkway, two supply air ducts are provided under each mainline roadway in order to efficiently connect flues to each curb.

The mechanical Directive Drawings reflect the preliminary engineering of those elements of the ventilation system which affect final design of the I-93 Central Artery Causeway to North tunnel structure and Ventilation Building No. 4; these include supply air duct cross-sectional area, supply air flue geometry and spacing, tunnel-to-building transitions, and fan equipment arrangements and spacing. Verification of this information will be performed by the I-93 Mechanical/Electrical Systems Section Design Consultant who is responsible for the final design of the ventilation system.

10.3 Tunnel Drainage

A drainage system will be included within the I-93 Central Artery Causeway to North tunnel and associated ramps. This drainage system is distinct from the storm drainage system and from the stormwater pump stations which are designed to collect run-off in the tunnel approaches adjacent to the portals and to prevent stormwater from entering the tunnel at the portals.

For the purposes of design, it has been assumed that during a 50-year storm event, a certain amount of run-off will by-pass the transverse storm drain at the portal(s) and thus contribute influent to the tunnel drainage system. Another major contributor considered in the preliminary design of the tunnel drainage system is the amount of water resulting from fighting an in-tunnel fire.

Although there are other contributors of the tunnel drainage system such as vehicle drippings, structure seepage and ventilation duct drainage, these are all assumed to be negligible and considered to have no effect on the system's capacity. Preliminary calculations of inflow resulting from tunnel wash down operations indicate that this flow would be less than that of a fire fighting operation.

The tunnel drainage system, as described in the "Tunnel Drainage Concept Report," consists of an embedded gravity drain pipe running longitudinally below the curb on the low side of each super-elevated roadway which will collect the drainage water through inlets spaced at a maximum of 75 feet. In the Central Artery area, the drainage flows to low points of the tunnels. From the low points the drainage is directed to a low point pump station located in Ventilation Building No. 4. After primary treatment by oil/water separation the effluent is discharged to an adjacent combined sewer.

The drainage low points(station, elevation) of the Central Artery Causeway to North Tunnel and its associated ramps as described in the "Tunnel Drainage Concept Report" are as follows: low point SA-CS(STA. 44+25, EL. 52.8), low point SA-CT(STA. 47+50, EL. 75.0), low point CS-SA/CT(STA. 48+30, EL. 54.5), low point ST-CN(STA. 51.75, EL. 55.6), low point ST-SA(STA. 48+65, EL. 77.3), low point CANB(STA. 144.5, EL. 47.8), and low point CASB(STA. 145.5, EL. 46.8). All of the low points listed above drain by gravity to a collector running transversely across the alignment to Pump Station N-1 which is located in Ventilation Building No. 4. Pump Station N-1 provides pumping capacity for pumping the collected tunnel drainage to a 36-inch diameter Combined Sewer in the vicinity of Ventilation Building No. 4.

The I-93 Mechanical/Electrical Systems Section Design Consultant will be responsible for overall final design of the tunnel drainage systems including all pumps, valves, exposed intermediate piping, motor starters, oil/water separators and other appurtenances. The I-93 Mechanical/ Electrical Systems Section Design Consultant will also provide verification of the preliminary engineering and directive information including piping dimensions, piping requirements and inlet spacing and sizes affecting final design of the I-93 Central Artery Causeway to North area structures.

The elements of the tunnel drainage system which are to be designed as part of the I-93 Central Artery Causeway to North tunnel and associated ramps structure include embedded gravity drain pipes and inlets, embedded and buried discharge piping and all miscellaneous embedded drains such as the walkway gutter drains, exhaust air duct drains and miscellaneous niche drains which will discharge directly on the roadway.

10.4 Fire Protection

As described in the "Fire Protection Concept Report," numerous subsystem elements will be integrated to provide an efficient and effective fire protection and detection system throughout the Central Artery/Third Harbor Tunnel project. As a part of this overall fire protection system, a system of dry standpipe zones shall be provided within the Central Artery tunnels and ramps.

Within the tunnel and associated ramps, the system shall consist of a single main header mounted above each ceiling. A riser will extend from the main header down to a niche, providing a two-way gated hose valve connection mounted against the wall. Each zone shall be capable of being pressurized from either end via at-grade siamese hydrants. The specific location of these hydrants shall be coordinated with and approved by the City of Boston Fire Department.

Verification of pipe sizes, valve arrangements and system schematic will be performed by the D020B SDC. The D015A SDC is responsible for the preparation of contract plans for the fire protection system.

10.5 Temporary Mechanical Systems

Temporary systems will be necessary during construction of the I-93 Central Artery Causeway to North tunnel and associated ramps. These systems include de-watering, heat and ventilation for the health and safety of workers, and a water supply and standpipe system for fire protection. The permanent mechanical systems for tunnel drainage, ventilation and fire protection are not to be considered available for use by the construction contractor(s) during construction.

The above requirements shall be reflected by the I-93 Central Artery Causeway to North Section Design Consultant in the contract documents for the construction of the I-93 Central Artery Causeway to North tunnel and associated ramps and shall include all codes, regulations and/or guidelines pertinent to the provisions of such temporary systems.

11.0 ELECTRICAL SYSTEMS

11.1 General

Final design of the electrical systems necessary for Ventilation Building No. 4, Storm Water Pump Stations 15A-SW01, 15A-SW02, and 15A-SW03 and surface street lighting, shall be performed by the D015A Section Design Consultant, in accordance with Project Design Criteria and Standard Special Provisions, Directive Drawings and Standard Drawings.

The D015A SDC shall incorporate into the design certain electrical elements which will be designed by the I-93 Mechanical/Electrical Section Design Consultant (Contract D020B). Contract D020B electrical elements include, but are not limited to, the following: specific embedded conduits and pull boxes, manholes, grounding system, ramp exterior roadway lighting pole foundation locations and space requirements for major electrical equipment such as switchgear, unit substations, motor control centers, generators and electrical panels. Additional specific electrical elements with which the D015A SDC shall coordinate are discussed in Chapter 12, Integrated Project Control Systems (IPCS).

Directive Drawings have been prepared to assure compatibility of the tunnel design with the projectwide electrical system. Preliminary engineering has established approximate equipment sizes, conduit and pull box sizes, quantities and locations, manhole sizes and locations and ramp exterior roadway light pole locations and facilitated the typical arrangement and orientation of these elements with other projectwide elements and structural requirements.

The D020B I-93 Mechanical/Electrical Section Design Consultant and the IPCS Section Design Consultant (Contract D022A) have final design responsibility for the mechanical, electrical and IPCS systems. They will be responsible for verifying the electrical information shown on the Directive Drawings. The Contract D020B and Contract D022A Section Design Consultants will provide technical guidance and general coordination to the D015A SDC. The Construction Documents for the embedded items shall be the responsibility of the D015A Section Design Consultant.

The following sections provide a description of each of the electrical systems and how they affect the final design of I-93/Central Artery North Street to Causeway Street. IPCS related electrical systems are described in Chapter 12.

11.2 Tunnel and Exterior Roadway Lighting

11.2.1 Tunnel Lighting

The tunnel lighting system will consist of multiple rows of fluorescent lighting fixtures mounted on the ceiling. Tunnel

portal (entrance) lighting will be supplemented by low pressure sodium (LPS) lighting fixtures. Typical locations and mounting details are shown on the Directive Drawings.

The lighting fixtures will be fed from two independent distribution circuits. Tunnel lighting circuits will be arranged so that alternate rows are fed from an alternate source to minimize the impact due to the loss of a circuit. Additional lighting circuits, originating from an uninterruptible power supply will provide standby power to certain lighting fixtures. Typical conduit and pull box requirements for the lighting circuits are shown on the Directive Drawings.

11.2.2 Exterior Roadway Lighting

Lighting of exterior ramps will be from pole mounted high pressure sodium (HPS) luminaires as shown on the Directive and Standard Drawings.

Pole foundations shall be designed per the Project Design Criteria, Section VIII - Electrical. Typical locations, mounting details and conduit and pull box requirements are shown on the Directive and Standard Drawings.

Lighting of surface streets shall be designed by the D015A Section Design Consultant in accordance with the standards of the Authority Having Jurisdiction over the roadway, i.e. City of Boston Public Works Department.

Electric service for lighting of exterior ramps will be supplied from load centers located in Ventilation Building No. 4. Electric service for lighting of surface streets shall be supplied by extension of existing street light wiring.

11.3 Power Distribution

11.3.1 General

The power distribution system will distribute primary power from the Boston Edison Company (BECO) to project ventilation buildings. From the ventilation buildings, secondary power will be distributed to tunnel ventilation, roadway drainage, lighting, IPCS, building service, and various miscellaneous electrical loads. One-line diagrams of the power distribution system are shown on the Directive Drawings.

11.3.2 Primary Distribution

The primary switchgear equipment will be located in the ventilation buildings and will be interconnected by two feeders, creating a power distribution network at a voltage level of 13,800 volts. The power source for this network will be three BECO substations, each providing two independent feeders. A tie-in to BECO will be established at Ventilation Building No. 4. A ductbank shall be designed by the D015A SDC to make this

tie-in to BECO in the vicinity of Hanover Street.

Two 13.8 kV ductbank and pull box systems, one in each roadway (northbound and southbound), will provide redundant routes for the interconnection of primary power between Ventilation Building Nos. 4 and 3.

11.3.3 Secondary Distribution

Secondary voltage will be required at 480/277V, and 208/120V levels. The 480/277V will serve the ventilation fan motors, roadway lighting, IPCS, drainage pump motors, and building service loads. Power at 208/120V will be derived by local, dry-type transformers from the 480V system, and will serve building service and IPCS loads.

The D015A Section Design Consultant shall design the building service electrical distribution system in accordance with the Project Design Criteria and Standard Special Provisions.

The D020B I-93 Mechanical/Electrical Section Design Consultant will be responsible for identifying the conduit system and structural opening requirements for the major electrical equipment for which he has final design responsibility. The IPCS Section Design Consultant will be responsible for identifying similar requirements for the IPCS equipment. The D015A SDC shall be responsible for the Construction Documents of the embedded portions of these conduit systems and any structural openings required for the major electrical and IPCS equipment.

Typical requirements for conduit systems embedded in the roadway structures are shown on the Directive Drawings.

11.3.4 Stand-By Power

A diesel engine generator located in Ventilation Building No. 4 will provide standby power in the event of a loss of normal power. Standby power loads are identified on the Directive Drawing showing the Ventilation Building No. 4 one-line diagram.

The provision for a fuel oil storage tank shall be designed by the D015A SDC in accordance with all State and Federal regulations.

Two separate uninterruptible power supplies (UPS) located in Ventilation Building No. 4 will provide uninterruptible power to selected loads. One UPS will be provided for IPCS loads. The other UPS will be provided for tunnel lighting, ventilation building standby lighting and circuit breaker control loads.

11.4 Temporary Construction Electrical Systems

During construction, a temporary lighting system, including emergency lighting, will have to be provided. Past projects have successfully used high pressure sodium lighting during construction. The design of this system shall be the

responsibility of the D015A SDC. The design should include identifying necessary equipment, location of equipment and maintenance of the system.

During construction, an interim power system will be provided by the contractor. The design of this system shall be the responsibility of the D015A SDC identifying service voltage levels, necessary equipment, location of equipment and maintenance of the system.

Requirements for turning the interim lighting and power systems over to follow-on contractors must be identified.

The D015A SDC shall include all codes, regulations and/or guidelines pertinent to the provisions of the above temporary systems in the Construction Documents.

11.5 Corrosion Control

Corrosion control for all steel structures, steel reinforcing, fire protection system and fuel oil storage tank, if steel, shall be designed in accordance with the Project Design Criteria, Standard Special Provisions, Directive Drawings and Standard Drawings.

11.6 Ventilation Building No. 4 Auxiliary System

Besides the building services conduit systems described above, the D015A Section Design Consultant shall design the following electrical systems, in their entirety, in accordance with Project Design Criteria and Standard Special Provisions:

- Building service power system
- Lighting, interior and exterior
- Fire detection and alarm system
- Security system
- Lighting protection

The fire alarm and security systems shall be designed to interface with the IPCS at system interface terminal cabinets. The IPCS SDC will be responsible for identifying the requirements of these interface terminal cabinets. The Construction Documents of these interface terminal cabinets shall be the responsibility of Contract D015A SDC.

12.0 Integrated Project Control System (IPCS)

12.1 General

The design of the Integrated Project Control System is the responsibility of the D022A Section Design Consultant. The system is described here to provide the D015A Section Design consultant (SDC) with a better understanding of the completed project.

The overall system, as planned, will be integrated, with thousands of signals that will be transported over fiber optic links between the centralized information display/decision/control points and a distributed network of many intelligent multipurpose Remote Terminals Units (RTUs). Visual support in the form of Closed Circuit Television (CCTV) as well as associated telephone and radio voice communications systems are also planned. The Integrated Project Control System will support all administrative maintenance, tactical and emergency responses.

A key item for D022A is the location of the Remote Terminal Units (RTUs). In general they will be located near concentrations of input/output points. This includes cross-passage/utility rooms, ventilation structure and the toll plaza complex.

Another key element of D022A is selection of the cross-passage and utility rooms for IPCS purposes. Selection for a particular room is dependent upon the distance from the sensor/display to its controller. The limiting factor is the TSCS, more specifically the Variable Message Sign (VMS). This sign must be located within 300 cable feet of its controller, which, like an RTU, will be located in a "cross-passage" room.

All IPCS cabling including fiber optic, where ever possible will be routed via embedded conduits.

12.2 Centralized Operations

Both operator and supervisor level staff will exercise control from either of two redundant Operations Control Centers (OCCs) using consoles dedicated to single or groups of functions Data will be collected during normal operation on the basis of polling for exceptions, with control being chiefly semiautomatic with manual override capability.

Voice communications between personnel at the OCCs, Toll Plaza, Maintenance Center, along the roadways of the project and off site, whether at fixed or mobile locations, is to be accomplished using radio and telephone.

12.3 Individual Systems

- Traffic Surveillance and Control System (TSCS)

The TSCS will provide automatic monitoring of traffic movement with incident situations being alarmed at the control

center. The TSCS will also provide control of traffic movement through variable message signs and signals. Operationally, the system will be configures based on supervisory control strategies, which are initiated either manually by the operator or as an automatic response to an incident situation.

Remote Terminal Units (RTUs), for localized concentration of sensor data and dissemination of control signals, will be located in utility rooms. Signs and CCTV cameras will be located above the vehicle travel lanes. Loop detectors will be located in the roadway pavement. Overheight detectors will be located at appropriate portals and entrance ramps.

o Ventilation and CO Level Control

The ventilation system will be controlled on a zone basis. CO will be monitored and air flow level adjusted through the use of local fan controllers which are interfaced to RTUs.

o Electrical Load Distribution Control

The system will monitor status of electrical power distribution for specific loads and provide limited control to allow load shedding and circuit breaker operation.

o Fire Detection and Protection

Basic fire detection will be accomplished via a linear heat detecting tube in each bore, suspended from the ceiling. Additional "spot" detectors will be provided. The fire detection and protection system will be capable of independent use by the Boston Fire Department (BFD). Sensors will be wired directly to both the BFD and the IPCS. A zone concept will be employed, utilizing automated detection, manual pull stations, and emergency telephones. The IPCS will monitor the status of the suppression equipment but will not control it.

o Security

Security devices will be used to protect against unauthorized access. Entry/exit points will be monitored by the OCC through RTU communications. Security points will be configured as alarms at the OCC.

o Drainage Control

The drainage systems will operate under a similar control regimen as that proposed for ventilation. Additional considerations for fuel/oil collection and disposal will be taken into account. Hydrocarbon detection devices will be provided at the sumps and will be monitored, with associated alarm signals sent back to the OCCs.

o Communications Facilities

Two basic communications systems will be available to CA/T personnel providing voice contact with others:

1. Telephone instruments will be located throughout the CA/T project. They will be connected to branch exchanges which will allow supervisory programmed access to other telephone instruments in both the public and private sector. A telephone will also be located in each "cross-passage" to provide voice communications throughout this area.

2. Two-way radio systems will be available to contact agencies providing service on the CA/T roadway network. Highway Advisory Radio is planned to broadcast messages to the motoring public. The basic radio communications medium will be redundant broad spectrum radiating cable, suspended from the ceiling of each bore.

13.0 Operations and Maintenance

13.1 General

The operations and maintenance concepts are presented here to provide the Section Design Consultant with an overall understanding of the completed project. Detailed requirements will be described in the Operations and Maintenance Manual. Factors for the SDC to incorporate into their project design should include:

- System Component labelling.
- Product consistency, i.e., minimize the number of vendors for each equipment type.
- Transferral of all vendor catalogs and data sheets to project operator.
- Evaluation of spare parts and specialized tool requirements.
- Product reliability statistics.

13.2 Operating Concepts

The following subsections provide a brief description of the operating parameters and the control philosophies.

Traffic

The TSCS monitors motorist activity and provides for minimum delays and optimum throughout by providing the operations staff with accurate and current information. Operators will evaluate the information, choose from the menu options and implement the various traffic strategies necessary to alleviate congestion.

The D022A SDC will develop response procedures to include the following actions by the operations staff pertaining to traffic surveillance and control.

- response to a detection alarm
- verification by CCTV monitors, roadway display graphics or on-site personnel
- dispatching emergency response crews
- implementing pre-selected traffic control strategies
- broadcasting of radio messages to motorists
- supervising operations via CCTV
- advising outside agencies affected by changes

A number of strategies will be developed to handle the changing roadway conditions.

Traffic control strategies will include:

- Normal Traffic Flow
- Lane and Roadway Closure
- Congested Traffic Flow
- Incidents
- Fire

- Ramp metering
- Roadway surface changes
- Visibility changes

System Monitoring

The IPCS will report on the status of all project equipment. In addition to the traffic related equipment, the OCC will be provided with both warning and trouble alarms on various mechanical and electrical equipment. A few of the conditions to be monitored are as follows:

- traffic volume and occupancy detectors
- mechanical and electrical equipment status
- carbon monoxide and hydrocarbon levels within confined areas
- security alarms
- overheight and overweight vehicle detection

When the equipment produces an alarm, the operator will choose from a menu of options which will rectify or address the immediate condition and will notify maintenance supervision. There will be close coordination between both the operations and the maintenance staff until the equipment is back in operation.

System Control

Given the magnitude of this project and the number of systems and equipment, there is a need for remote as well as local control.

Control strategies will be developed for the following:

- bypass configuration during repair and replacement
- emergency operations
- abnormal condition response

The strategies will require both internal and external agency coordination

Fire Protection/Detection

There are several devices which will signal a fire. Operators will verify the severity and type of fire using in-tunnel CCTV and will view their monitors for alarm condition locations. The OCC will also initiate a call to the Boston City Fire Department dispatcher via direct telephone line to verify the alarm and location plus set up a communications link with responding units.

Ventilation fans for the zone in which the fire is located will be switched to the exhaust mode and the supply side will be reduced. Ventilation strategies are complex and will be modeled for the facility.

Policing

The State Police will be governed by the present agreement between the Department of Public Safety and the Massachusetts Turnpike Authority.

The project will also be employing ramp metering during peak periods which will require enforcement. All communications between the State Police and the facility will be directed through the Operations Control Center. The State Police frequency will be monitored by the Control Center for reports concerning the operations and maintenance of the Central Artery/Tunnel Facilities.

Emergency Access/Egress

In the event of an emergency, the Operations Control Center may need to evacuate a portion of the facility. Emergency stairs are being designed both for the egress of motorists and the access of emergency and fire personnel.

Cross passages between tunnel sections will also be monitored by the OCC. All doors will be numbered for quick identification on a graphic alarm system.

Security

The OCC will also oversee the security of the entire facility. Operators will be notified of an intrusion into any of the project buildings and will contact the appropriate enforcement agency for response.

13.3 Maintenance Concepts

Maintenance activities can be divided into one of five categories.

1. Inspecting
2. Testing
3. Cleaning
4. Preventive Maintenance
5. Repair and Replacement

Inspections

Inspection schedules will be generated based on manufacturers recommendations and shall be conducted to identify early warning signs of failure.

Testing

Testing of all equipment shall be scheduled to check performance and control logic. Testing shall be accomplished periodically to assure equipment meets specifications.

Uninterrupted power supplies and battery systems will be

checked periodically. Fan cycling and speed control will also be checked periodically. Corrosion control systems will require frequent scheduled testing.

Cleaning

An aggressive cleaning program is required. Maintenance personnel will be performing basic janitorial duties within each of the facilities buildings including cleaning floors, washing windows, refuse removal and servicing rest rooms. There will be a need to pressure wash the buildings regularly, and clean up including sweeping of roadways. The clean up of the grounds and park lands are also required. Cleaning will also be required on the drainage systems and throughout the project's major structures.

With an average annual snowfall of 42 inches in the Boston area, snow removal activities will be carefully planned and implemented by the operation and maintenance group. Ramps and boat sections will be cleaned to provide minimum disruption to traffic flow.

Preventive Maintenance

All project equipment will be incorporated into a component and system labelling program. Under this format, a computerized maintenance management system will be instituted in which a scheduled preventive maintenance program will be implemented.

Repair and Replacement

There will be a need for both repair and replacement of equipment. It will be necessary to maintain spare parts and provide storage, a computerized system for inventory control, and warranty administration.

Equipment will be transported to the central maintenance site for replacement or will be brought to an electrical/ mechanical workshop to be repaired.

Each of these four maintenance categories will need to be provided on the project. These elements can be grouped under the following headings.

- Major structures
- Roadways and grounds
- Vehicles and heavy road equipment
- Mechanical and electrical equipment

Major Structures

Major structures on the CA/T Project include:

- Third Harbor Tunnel
- Seaport Access Tunnel

- Central Artery Underground Freeway
- CANA Ramps
- South Boston Interchange
- Service and Administration Building
- Toll Plaza Facility
- Ventilation Buildings
- Emergency Stations
- Roadway Maintenance Buildings
- Pump Stations
- Electrical Substations

Roadway and Grounds

There will be a need to maintain residual land adjacent to the roadway. This will include the maintenance of all trees, shrubs, flowers and grass.

Vehicles and Heavy Road Equipment

The maintenance group will be responsible for the upkeep of all the facility vehicles and equipment. They will install the necessary equipment into all State Police Vehicles and provide any necessary repairs.

Mechanical and Electrical Equipment

A preliminary list of M&E equipments to be maintained is as follows:

- 13.8 KV Substations
- 13.8 KV 480 V Unit Subs
- Motor Control Centers
- 13.8 KV Breakers
- Diesel Generators
- Battery Rooms
- Ventilation Fans
- Drainage Pumps
- Numerous roadway and tunnel lights.

14.0 Right-of-Way Impacts

14.1 Major Property Owners

The major property owner in the D015A contract is the City of Boston. The properties are used mainly for off-street parking. Other property owners include but not necessarily limited to are the Commonwealth of Massachusetts Department of Public works, James F. Sullivan, trustee of D. S. Parking Trust, Joseph J. Terce and Fred W. Allison, Maurice W. Dennison and Thomas G. Lynch, trustees of Braham Dow Company.

14.2 Impact Upon Properties

There should be no fee takings as part of this project. The major impact will be limited to permanent sub-surface easements together with temporary construction easements. The majority of impact should be within the existing State Highway location lines as established in the 1950's.

14.3 Affected Buildings

There should be no impact to any buildings in this contract.

15.0 Traffic

15.1 General

This chapter of the Preliminary Design Report describes the traffic operating conditions on the highway and local street system within the Design Contract D015A portion of the Central Artery (I-93)/Tunnel (I-90) Project (CA/T Project). All of the CA/T Project Design Contract D015A project components are located within the City of Boston. The existing I-93 Northbound and Southbound mainline roadway through the City of Boston is commonly referred to as the Central Artery within the North Street to Causeway Street corridor. The Central Artery area of the CA/T Project contains the following major highway components as shown in Figure 1, Proposed Action, Design Contract D015A Project Alignment.

- A new I-93 Northbound mainline roadway tunnel (beginning under Atlantic Avenue south of Kneeland Street to north of Causeway Street) to where the I-93 Northbound mainline roadway emerges from tunnel to cross over the Charles River on viaduct structure.

- A new I-93 Southbound mainline roadway tunnel starting just north of Causeway Street where the roadway has descended from the Charles River crossing viaduct structure. From Causeway Street, the I-93 Southbound mainline roadway continues in a southerly direction to the existing Dewey Square Tunnel south of Congress Street. Continuing south from Congress Street, the I-93 Southbound mainline roadway enters the existing Dewey Square Tunnel to the terminus south of Kneeland Street beyond the Design Contract D015A study area limits.

- A new below grade interchange connecting the existing Sumner and Callahan Tunnels directly to the Central Artery roadway system to the north.

- A continuous, northbound and southbound surface arterial street system from south of North Street (Kneeland Street) to Causeway Street composed of new and existing roadways. The existing roadway network is comprised of sections of surface arterial roadway. Under the Proposed Action alignment, the existing arterial street system will be rebuilt and extended from approximately North Street to Causeway Street.

- New on and off ramps from the Proposed I-93 Northbound and Southbound mainline tunnel roadway system to the surface arterial street system.

- New extensions to the local roadway system between the proposed northbound and southbound surface arterial streets within the existing Central Artery corridor.

The CA/T Project Design Contract D015A study area limits extend from North Street to Causeway Street from south to north. To the east and west, the Design Contract D015A study area is bounded by the proposed northbound and southbound surface arterial street system included under the CA/T Project Proposed Action alignment. CA/T Project components included in the Design Contract D015A study area include the I-93 Northbound and Southbound mainline highway elements, an interchange with the existing Sumner and Callahan Tunnels, a northbound and southbound surface arterial street system from North Street to Causeway Street and the local street system roadway network improvements considered relevant to the operations of the CA/T Project highway components.

This report addresses future travel demand and general traffic composition, and then proceeds to a detailed discussion of the I-93 mainline operations including ramp operations, weaving sections and surface street operations within the CA/T Project Design Contract D015A study area.

The traffic operations of the CA/T Project area components located to the north of the Design Contract D015A study area are discussed in reference to Design Contract D019A and D019B within the I-93/Central Artery Causeway Street to North Area Limits Traffic Report. South of the Design Contract D015A study area, traffic operations of the CA/T Project area components are discussed in reference to Design Contract D017A. The traffic operations of both Design Contract D015A and D017A as well as the other CA/T Project design areas located between Kneeland Street and Causeway are discussed within the I-93/Central Artery Central Area Traffic Report.

Year 2010 - Design Year Traffic Volume Estimation

Traffic volume forecasts were generated using the CA/T TRANPLAN travel forecasting computer model. The model determines total travel demand throughout the CA/T Project study area based on land use activity forecasts and an estimate of vehicle trips generated per land use activity. The trips generated are then assigned to the study area roadway network based upon the criteria that a vehicle will travel from its origin to its destination along the route requiring the least travel time. A more detailed description of the travel forecasting methodology used is documented in the Central Artery/Third Harbor Tunnel Project Detailed Travel Model Documentation Report. The traffic analyses have been conducted for the Year 2010 Build conditions, the CA/T Project design year.

From the CA/T TRANPLAN travel forecasting computer model, AM and PM peak hour traffic volumes within the project study area boundaries were generated for analysis purposes. The Average Weekday Traffic (AWDT) volumes within the CA/T Project study area boundaries were generated for comparison purposes. The AM and PM peak hour traffic analysis of the CA/T Project roadway components located within the Design Contract D015A limits are discussed in the following pages of this report.

Figure 2, Proposed Action, Design Contract D015A Project Alignment Major Facilities Traffic Volume Forecasts, Year 2010, shows the projected peak hour traffic and AWDT volumes forecasted for the I-93 mainline roadways located within the Design Contract D015A limits based on the Year 2010 TRANPLAN model. Figure 2 also displays forecasted traffic volumes for all of the I-93 mainline roadway ramps which connect the Central Artery with the Sumner and Callahan Tunnels as well as the surface arterial street system.

Figure 3, Proposed Action, Design Contract D015A, Selected Roadway Forecasted Peak Hour and AWDT Volumes, Year 2010 shows the AM and PM peak hour traffic volumes and AWDT traffic volumes on select roadways within the CA/T Project Design Contract D015A limits. The surface arterial and local street roadways within the Design Contract D015A study area Design Year 2010 TRANPLAN generated AM and PM peak hour turning movement traffic volumes are shown on Figure 4 Proposed Action, Design Contract D015A, Peak Hour Intersection Turning Movement Volumes, Year 2010. The local street peak hour traffic operations forecasted for the Year 2010 are discussed within the I-93/Central Artery Central Area Traffic Report.

The year 1998 "opening day" peak hour traffic volumes forecasted for the local street system within the Design Contract D015A study area are shown on Figure 5 and Figure 6. Figure 5, Proposed Action, Design Contract D015A, Selected Roadway Forecasted Peak Hour Volumes, Year 1998 and Figure 6, Proposed Action, Design Contract D015A, Peak Hour Intersection Turning Movement Volumes, Year 1998 reflect peak hour traffic volumes on the local street system when the I-93 mainline tunnel roadway is open to traffic and the existing Central Artery viaduct is dismantled throughout Downtown. The 1998 traffic volumes were generated in the same manner as the Year 2010 TRANPLAN model forecasts.

Level of Service Description

Level of Service (LOS) is defined as a qualitative measure describing operating conditions that include such factors as speed, travel time, maneuverability, and safety. As noted in the 1985 "Highway Capacity Manual" (HCM) Special Report 209 by the Transportation Research Board there are six defined Levels of Service with letter designations from "A" to "F". LOS "A" represents the best traffic operating characteristics with free flow conditions. LOS "F" traffic operations describe the worst conditions or failing traffic operations with high levels of delay and or congestion experienced by motorists. These conditions are briefly described below for basic freeway segments, freeway weaving areas, ramp merges and signalized intersections.

LOS Criteria for Basic Freeway Segment

For basic freeway segments, the density of the traffic stream based on the traffic volume demand and the available roadway capacity (number and width of available travel lanes) is the parameter used to define LOS. The densities used to define the various LOS are as follows:

Criteria for Basic Freeway Sections

LOS	Characteristics	Density (Passenger cars mile/lane)
A	Free flow, highest speed, highest maneuverability	≤ 12
B	Stable flow, high speed, high maneuverability	≤ 20
C	Stable flow, medium speeds, less maneuverability	≤ 30
D	Stable flow, medium speeds, high density	≤ 42
E	Unstable flow, low speeds, higher density	≤ 67
F	Breakdown in flow, stop-and-go speeds highest density	> 67

LOS Criteria for Ramp Merges

The operational characteristics of ramp merges are dependent on the merge flow rate in passenger cars per hour (pcph) at the intersection point of the merging ramp and mainline roadway to which the ramp is merging. The merge flow rate is comprised of the ramp traffic and mainline roadway "lane 1" traffic volume. Lane 1 is the mainline roadway travel lane adjacent to the ramp merge and consequently the travel lane most impacted by the ramp merge effects.

The HCM merge flow rate criteria used to define LOS include:

LOS Criteria for Ramp Merges

Level of Service	Merge Flow Rate (pcph)
LOS A	≤ 650
LOS B	≤ 1050
LOS C	≤ 1500
LOS D	≤ 1800
LOS E	≤ 2000
LOS F	Widely Variable

LOS Criteria for Highway Weaving Areas

Highway weaving areas are defined as two or more traffic streams moving in the same general direction on a limited access roadway section which typically includes a ramp merge followed by a ramp

diverge. The two traffic streams are composed of one stream entering from the mainline roadway upstream of the ramp merge and the second traffic stream entering from the ramp. Vehicles in both the upstream mainline roadway traffic and the ramp traffic may be destined for either the mainline downstream roadway or the off ramp. One or both of the traffic streams are required to change travel lanes at least once to reach the appropriate downstream destination (mainline downstream roadway or the off ramp). The weaving area proper is the mainline roadway bordered by the ramp merge upstream and the ramp diverge downstream if within 2500 ft.

The variables involved in determining the operational characteristics of a highway weaving area are the weaving area geometry as well as the number of lane changes required by both the upstream mainline roadway to access the off ramp, and, the on ramp to access the downstream mainline roadway. The weaving area roadway profile grade, design speed and the heavy vehicle presence in the right most mainline roadway travel lane upstream of the ramp merge are also factors used to determine the operational characteristics of weaving areas.

The procedures described in the HCM and as implemented in the Highway Capacity Software (HCS) distributed by McTrans Center for the FHWA were used to evaluate the weaving areas located on the I-93 Northbound and Southbound mainline roadways located within the Design Contract D015A portion of the CA/T Project. The LOS results of the weaving analysis are expressed in terms of the travel speed of both the weaving and non-weaving vehicles travelling through the weaving area are described as follows:

LOS Criteria for Highway Weaving Areas

LOS	Minimum Avg. Weaving Speed (mph)	Minimum Avg. Non-weaving Speed (mph)
A	55	60
B	50	54
C	45	48
D	40	42
E	35/30o	35/30o
F	<35/30o	<35/30o

o 35 mph boundary used when comparing to computed speeds

LOS Criteria for Signalized Intersections

The LOS analysis for signalized intersections was performed using the Massachusetts Environmental Protection Agency (MEPA) approved "CINCH" software program. CINCH utilizes the operational analysis methodology of the HCM. The operational analysis of signalized intersections is an evaluation of the capacity of an intersection considering the details of traffic signal timing and phasing in addition to roadway geometry and related pedestrian activity given the traffic demand. It

provides an assessment of whether or not the intersection capacity is likely to be exceeded for a given set of demand volumes and intersection geometry for the intersection as a whole and by intersection approach. The LOS results for signalized intersections analyzed using the CINCH program are expressed in terms of stopped delay per vehicle as described below:

Level of Service Criteria for HCM Operational Analysis

LOS	Characteristics	Stopped Delay Per Vehicle (Seconds)
A	Little or no delay, most vehicles do not stop at all.	5.0 or less
B	Short traffic delays, more vehicles stop than for LOS A causing higher average delay.	5.1 to 15.0
C	Average traffic delays. The number of vehicles stopping is significant, although many still pass through without stopping.	15.1 to 15.0
D	Long traffic delays. More vehicles stop on the average. Individual cycle failures become noticeable.	25.1 to 40.0
E	Very long traffic delays. LOS E is considered to be the limit of acceptable delay. Individual cycle failures are frequent.	40.1 to 60.0
F	Severe congestion. LOS F delay is considered to be unacceptable to most drivers. This condition often occurs with over saturation, i.e., when arrival flow rates exceed the capacity of the intersection.	greater than 60.0

LOS E is considered to represent capacity conditions with LOS F representing failing or over capacity conditions at a signalized intersection.

15.2 Highway Traffic Operations - Year 2010

The description of the highway operations for the roadways located within the Design Contract D015A study area have been subdivided into an I-93 Southbound Mainline Section and an I-93 Northbound Mainline section. The discussion of LOS operating conditions for these major roadways with respect to basic freeway operations, weaving areas, and, ramp merge and diverge operating conditions are described within the relevant major roadway section.

The LOS operating conditions of the local roadway system located within the CA/T Project Design Contract D015A study area are discussed separately within Section 15.3 of this report.

The Design Contract D015A study area I-93 mainline highway operating characteristics (traffic volumes, speeds, and LOS) are shown in Table 1, Proposed Action, Design Contract D015A, I-93 Northbound Mainline and Southbound Mainline Highway Operations, Year 2010.

I-93 Northbound Mainline

As previously discussed, the I-93 Northbound mainline roadway within the existing Central Artery corridor originates south of Kneeland Street as a three lane roadway tunnel travelling to the north under Atlantic Avenue to within the existing Central Artery roadway corridor just north of Summer Street. From Summer Street, the I-93 Northbound mainline roadway maintains four travel lanes in a northerly orientation to south of the Design Contract D015A southerly limit at North Street. At Hanover Street the I-93 Northbound mainline roadway maintains a +5.0% grade to the Charles River crossing, which generally speaking, results in slower travel speeds and a poorer LOS than would a level profile.

At State Street, Ramp A-CN/RT (from Northern Avenue/Essex Street) joins the I-93 Northbound mainline roadway where it continues as a four lane roadway to North Street at the Design Contract D015A southerly limit. North of the location where Ramp A-CN/R-T meets the I-93 Northbound mainline the forecasted traffic volume is 6690 vph with an operating speed of 40 mph and a LOS E in the AM peak hour. During the PM peak hour, the forecasted traffic volume is 8020 vph with an operating speed of 12 mph and LOS F. The LOS F operating conditions on the mainline roadway are the result of the 5% upgrade and lower travel speeds experienced by motorists further downstream of the Ramp A-CN/R-T merge as previously discussed.

The I-93 Northbound mainline roadway continues in a northerly direction, within the existing Central Artery corridor, from North Street as a four lane roadway section to south of Causeway Street where it is joined by a right-side, one lane Ramp ST-CN (Sumner Tunnel to Central Artery Northbound). The point at which Ramp ST-CN joins the I-93 Northbound mainline roadway is an "add-a-lane" situation as defined in the HCM where the I-93 Northbound mainline continues to the north as a five lane roadway. Operating conditions of LOS C are expected during the AM and PM peak hour on Ramp ST-CN approaching the I-93 Northbound mainline roadway.

North of Ramp ST-CN, the I-93 Northbound mainline roadway continues as a tunnel section until it passes under Causeway Street. From just north of Causeway Street the I-93 northbound mainline roadway tunnel section ends and the mainline roadway

transitions to a boat section then to a bridge crossing over the Charles River. North of Ramp ST-CN, the I-93 Northbound mainline has a forecasted traffic volume of 7570 vph with an operating speed of 34 mph and a LOS E in the AM peak hour. During the PM peak hour, the forecasted traffic volume on the I-93 Northbound mainline roadway is 8900 vph with an operating speed of 12 mph and LOS F.

Table 1:

Proposed Action Design Contract D015A

I-93 Northbound and Southbound Mainline Highway Operations

Year 2010

	Peak Hour Volumes		Peak Hour Speeds		Levels of Service	
	A.M.	P.M.	A.M.	P.M.	A.M.	A.M.
I-93 Northbound Mainline						
North of On-Ramp A-CN/RT	6690	8020	40	12	E	F
On-Ramp ST-CN south of I-93 (NB) merge	880	880	*	*	B	B
North of On-Ramp ST-CN	7570	8900	34	12	E	F
I-93 Southbound Mainline						
North of Off-Ramp CS-CT	9470	8430	25	35	F	E
Off-Ramp CS-CT south of Ramp CS-SA diverge	840	950	**	**	**	**
South of Off Ramp CS-CT	7330	6900	13	30	F	E

* Add lane to the I-93 Northbound mainline roadway.
** Off Ramp speed and LOS based on traffic conditions downstream of diverge from the I-93 Northbound mainline roadway.

To the north of Causeway Street, the I-93 Northbound mainline roadway section enters the Design Contract D019B study area limits.

I-93 Southbound Mainline

The I-93 Southbound mainline roadway enters a tunnel section north of Causeway Street as a five lane roadway section and continues in a southerly direction within the existing Central Artery corridor through the City of Boston. As in the I-93 Northbound mainline roadway, the I-93 Southbound mainline roadway enters the Design Contract D019B study area limits to the north of Causeway Street. During the AM peak hour 9470 vph will travel southbound on the I-93 mainline roadway under Causeway Street with a travel speed of 25 mph and LOS F. During the PM peak hour 8430 vph will travel southbound on the I-93 mainline roadway with a travel speed of 35 mph and LOS E. Traffic flow within the I-93 Southbound mainline roadway is restricted due to traffic operations within a weaving section located downstream as discussed below.

In the vicinity of New Chardon Street, a right-side two lane Ramp CS-CT (Central Artery Southbound to Callahan Tunnel) diverges from the I-93 Southbound mainline roadway. South of the I-93 Southbound mainline roadway diverge, Ramp CS-SA (Central Artery Southbound to Surface Artery) splits off from Ramp CS-CT. Ramp CS-CT then continues as a one lane direct access ramp to the Callahan Tunnel and Ramp CS-SA provides access to the at-grade roadway system within the Downtown area via the proposed intersection of the Surface Artery southbound roadway and Clinton Street. Ramp CS-CT has a forecasted AM peak hour traffic volume of 2140 vph just south of the I-93 Southbound mainline roadway diverge. Of these 2140 vehicles exiting the I-93 Southbound mainline roadway at Ramp CS-CT during the AM peak hour, 1300 vph are expected to access the local street system from Ramp CS-SA. During the PM peak hour, the forecasted traffic volume on Ramp CS-CT is 1530 vph with 580 vph travelling to ramp CS-SA for access to the local street system. Traffic operations on Ramp CS-SA downstream of the diverge with Ramp CS-CT are described within Section 15.3 in reference to the peak hour operating conditions forecasted to occur within the local street system at the intersection of Ramp CS-SA with the Surface Artery southbound roadway in the vicinity of Clinton Street.

South of the Ramp CS-CT diverge, the I-93 Southbound mainline roadway continues as a four lane roadway with a forecasted traffic volume of 7330 vph in the AM peak hour and 6900 vph during the PM peak hour. A travel speed of 13 mph with LOS F operating conditions are forecasted on the I-93 Southbound mainline roadway south of the Ramp CS-CT during the AM peak hour. During the PM peak hour, this section of the I-93 Southbound mainline roadway has a forecsted LOS E with a travel speed of 30 mph.

At the intersection of New Chardon Street and the Proposed Surface Artery southbound roadway one lane Ramp SA-CS (Surface Artery to Central Artery Southbound) and one lane Ramp SA-CT (Surface Artery to Callahan Tunnel) form a southerly exit leg to the intersection. The Ramp SA-CS and Ramp SA-CT two lane roadway becomes a boat section as the Ramp roadway drops down to enter a tunnel structure at New Sudbury Street. From New Sudbury Street, Ramp SA-CT veers to the left where it merges with Ramp CS-CT to access the two lane Callahan Tunnel. Ramp SA-CT will be the only access to the Callahan Tunnel from Downtown Boston. Ramp SA-CT has a forecasted AM and PM peak hour traffic volume of 1670 vph and 2120 vph before the merge with Ramp CS-CT.

During the AM peak hour 2510 vph will travel through the Callahan Tunnel to East Boston from both one lane Ramp CS-CT and one lane Ramp SA-CT. The Callahan Tunnel is a two lane existing facility which can accommodate the two lanes of traffic entering from Ramps CS-CT and SA-CT. Capacity constraints on the East Boston side of the Callahan Tunnel are not an issue with the currently administered one-way toll system effective when motorists leave East Boston to travel via the Sumner Tunnel into Downtown Boston.

Ramp SA-CS merges with the four lane I-93 Southbound mainline roadway in the vicinity of North Street. From the Ramp SA-CS merge, the I-93 Southbound mainline roadway continues as a five lane roadway within what is defined by the HCM and as discussed in Section 15.1 as a "weaving area". The I-93 Southbound mainline weaving area is formed by the Ramp SA-CS merge to the north and the Ramp CS-P (Central Artery Southbound to Purchase Street) diverge to the south on the I-93 Southbound mainline roadway. The Ramp CS-P diverge from the I-93 Southbound mainline roadway occurs just south of State Street within the Design Contract D017A study area limits. Ramp SA-CS is forecasted to carry 1680 vph in the AM peak hour and 1350 vph during the PM peak to the I-93 Southbound mainline roadway. Travel speed and LOS on Ramp SA-CS are dependant on the operating conditions within the I-93 Southbound mainline roadway.

15.3 Surface Street Intersections

As previously mentioned, the CA/T Project Proposed Action roadway alignment includes a surface arterial street system. As part of the I-93 Northbound and Southbound Mainline tunnel and ramp construction, a northbound and southbound surface arterial street system will be created that will extend from Kneeland Street to Causeway Street and intersect with the City's local street system. The northbound and southbound surface arterial street system is designed to provide access to on-ramps and access from off-ramps so that motorists on the I-93 Northbound and Southbound Mainline with Downtown Boston destinations can use the surface arterial street system to access Downtown locations.

Within the CA/T Project Proposed Action roadway alignment Design contract D015A study limits an interim phase surface arterial street system (resulting from construction staging) is required in order to provide local street access to the I-93 mainline roadway until such time as all final design project elements are operational. These interim phase local street system designs will be operational until the completion of all construction related activities within the North Street to Causeway Street limits. Namely, the opening of the I-93 Northbound mainline roadway tunnel prior to the I-93 Southbound mainline roadway tunnel and the removal of the existing Central Artery viaduct structure between North and Causeway Streets is the final activity in this area and as such precludes the implementation of all final design roadway elements. Whenever possible however, the local street system interim phase designs should include elements of the final design if the existence and removal of the existing Central Artery viaduct is not perceived as a conflict. The final surface street system restoration which includes all urban design elements will occur within a future surface restoration Design Contract.

The surface arterial street system is composed of both existing city streets and new surface streets to provide the necessary continuity between North and Causeway Street. Figure 3, Proposed Action, Design Contract D015A, Selected Roadway Forecasted Peak Hour and AWDT Volumes, Year 2010 shows the AM and PM peak hour traffic volumes and AWDT traffic volumes on select roadways within the CA/T Project Design Contract D015A limits.

The surface arterial and local street roadways within the Design Contract D015A study area Design Year 2010 TRANPLAN generated AM and PM peak hour turning movement traffic volumes are shown on Figure 4 Proposed Action, Design Contract D015A, Peak Hour Intersection Turning Movement Volumes, Year 2010.

Within the Design Contract D015A limits Cross Street will be reconstructed from North Street to New Sudbury Street. From New Sudbury Street to approximately North Washington Street, Cross Street will be reconstructed directly over the I-93 Northbound mainline roadway. From the intersection of North Washington Street, the proposed Northbound Surface Artery will be constructed to Causeway Street where it terminates at a "T" intersection.

As shown on Figure 4, Cross Street intersects North Street at Ramp CN-SA, Hanover Street, New Sudbury Street, and, North Washington Street at Ramp ST-SA. The proposed Northbound Surface Artery which starts at North Washington Street, intersects Traverse Street and Causeway Street.

The proposed Southbound Surface Artery starts at Causeway Street in the vicinity of the Proposed Boston Garden garage driveway. Within the Design Contract D015A study area the Southbound Surface Artery roadway continues southbound from Causeway Street, towards North Street intersecting with New Chardon Street, New Sudbury Street, Hanover Street, and, North Street. North Street, New Sudbury Street and Traverse Street will be extended between the Northbound and Southbound Surface Artery within the Design Contract D015A limits. In addition, the intersections of New Chardon Street at Congress Street and New Sudbury Street at Congress Street are included within the Design Contract D015A study area limits. The CA/T Project roadway alignment within the local street system includes the redesign of New Chardon Street and New Sudbury Street form the proposed Southbound Surface Artery roadway to Congress Street. As a result of the redesign activity, the traffic operations at the intersection of Congress Street and New Chardon Street are included within the surface roadway street network evaluation.

The LOS analysis results for the surface roadway intersections included within the Design Contract D015A were performed by using the signalized intersection capacity analysis methodology based on the 1985 HCM criteria discussed in Section 15.1.

The results of the AM and PM peak hour signalized intersection analysis based in the 2010 TRANPLAN travel model data as previously discussed on the intersections located within the CA/T Project Design Contract D015A study area are shown in Table 2, Proposed Action design Contract D015A, Signalized Intersection Level of Service Analysis, Year 2010.

Table 2:

Proposed Action Design Contract D015A

Signalized Intersection Levels of Service Analysis

Year 2010

Intersection	AM Peak Hour LOS	PM Peak Hour LOS
Northbound Surface Artery at North Street	C	C
Northbound Surface Artery at Hanover Street	C	D
Northbound Surface Artery at New Sudbury Street	C	C
Northbound/Southbound Surface Artery at New Chardon Street and North Washington Street	F	E
Northbound Surface Artery at Traverse Street	D	C
Northbound Surface Artery at Causeway Street	C	C
Southbound Surface Artery At Causeway Street	B	C
Southbound Surface Artery at Traverse Street	B	C
Southbound Surface Artery at New Sudbury Street	C	D
Southbound Surface Artery at Hanover Street	B	B
Southbound Surface Artery at North Street	B	B
Congress Street at New Sudbury Street	F	E
Congress Street at New Chardon Street	E	C

15.4 Traffic Signal Warrants

Traffic signal warrant studies are required as a prerequisite to determining the necessity for signalizing the intersections located within the CA/T Project Design Contract D015A study limits. The traffic signal warrants evaluated are based on the 1988 FHWA Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD) signal warrant justification requirements. The MUTCD signal warrant justification evaluates intersection operations in terms of eleven different criteria in order to ascertain if a traffic signal is required. The installation of a traffic signal can be considered required when one or more MUTCD traffic signal warrants are met. The evaluation is based on intersection traffic volume data, existing traffic controls, pedestrian traffic flow volume data, accident data, local environmental conditions, and traffic peaking factors. The eleven traffic signal warrant evaluations discussed within the MUTCD include.

Warrant 1 - Minimum vehicular volume
Met when traffic volumes at the intersecting major and minor streets meet or exceed the criteria listed within the MUTCD during the same eight hours of an "average" day.

Warrant 2 - Interruption of continuous traffic
Met when traffic volumes on the major street are excessively high and traffic entering from the minor street is expected to experience excessive delay and or hazards. MUTCD lists major and minor street volume criteria required over an eight hour period of an "average" day.

Warrant 3 - Minimum pedestrian volume
Met when intersection or mid-block pedestrian crossing volumes exceed criteria specified in MUTCD.

Warrant 4 - School crossings
Satisfied when a determination is made that gaps in traffic are not sufficient to allow for the number and size of groups of school children at the school crossing.

Warrant 5 - Progressive movement
Met upon determination that providing a traffic signal will allow for better traffic flow or traffic progression within the traffic stream.

Warrant 6 - Accident experience
Generally met when accident frequency criteria shown in MUTCD is satisfied.

Warrant 7 - Systems

Met when traffic flow volumes during the peak hour exceeds 1000 vehicles in addition to meeting Warrants 1, 2, 8, 9 and 11 during particular time periods.

arrant 8 - Combination of warrants
Met when eighty percent of the criteria listed in Warrants 1 and 2 are satisfied.

arrant 9 - Four hour volumes
Satisfied when the traffic volumes listed in the MUTCD are met over a four hour period.

arrant 10- Peak hour delay (measured in the field)
Satisfied when due to extreme delay experienced on the minor street approach to a major roadway the criteria for delay experienced and/or traffic volumes on the minor street exceed the limitations listed within the MUTCD.

arrant 11- Peak hour volume
Met when the traffic volumes on the minor street approach to an intersection are in excess of the volume shown in the MUTCD over a one hour period.

raffic signal warrant analysis on intersections being designed s generally performed using data for "opening day" traffic flow onditions. The Design year 2010 TRANPLAN model was used as a asis for forming the Year 1998 Full Build traffic model network ndicating "opening day" traffic volumes on the CA/T Project oadway system. Within the CA/T Project Design Contract D015A imits, the five signal warrant thresholds pertaining to ehicular traffic flow (Warrants 1, 2, 8, 9, and 11) have been ully evaluated using the CA/T Project 1998 TRANPLAN traffic odelling network.

he results of the traffic signal warrant analysis performed for he intersections located within the Design Contract D015A imits are shown in Table 3, Proposed Action Design Contract 015A Vehicular Signal Warrant Analysis, Year 1998.

s shown in Table 3, all the intersections meet at least one of he signal warrants evaluated. Of the five signal warrants valuated at thirteen intersections, eleven intersections met hree or more of the signal warrants. Consequently, all of the ntersections will be designed with traffic signal control quipment.

Table 3:

Proposed Action Design Contract D015A

Vehicular Signal Warrant Analysis

Year 1998

Intersection	Vehicular Signal Warrant 1	2	8	9	11
Northbound Surface Artery at North Street	met	met	met	met	met
Northbound Surface Artery at Hanover Street	met	met	met	met	met
Northbound Surface Artery at New Sudbury Street	met	met	met	met	met
Northbound/Southbound Surface Artery at New Chardon Street and North Washington street	met	met	met	met	met
Northbound Surface Artery at Traverse Street	met	met	met	met	met
Northbound Surface Artery at Causeway Street	met	met	met	met	met
Southbound Surface Artery at Causeway Street	-	met	met	met	met
Southbound Surface Artery at Traverse Street	met	met	met	met	met
Southbound Surface Artery at New Sudbury Street	-	-	-	met	met
Southbound Surface Artery at Hanover Street	met	-	-	-	-
Southbound Surface Artery at North Street	met	-	-	met	met
Congress street at New Sudbury Street	met	met	met	met	met
Congress Street at New Chardon Street	met	met	met	met	met

FIGURE 1

Proposed Action-Central Artery/Third Harbor Tunnel Project

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT

0 400 800 1600 Feet

DESIGN CONTRACT
D015A

CASB
AM 7330
PM 6900
AWDT 98,430

RAMP ST-SA
AM 1920
PM 1400
AWDT 24,350

CASB
AM 9470
PM 8430
AWDT 121,120

CANB
AM 7570
PM 8900
AWDT 118,980

RAMP CS-SA
AM 1300
PM 580
AWDT 10,810

NEW CHARDON ST.

SA-SB

SA-NB

RAMP SA-CS
AM 1680
PM 1350
AWDT 23,010

CASB
AM 9010
PM 8250
AWDT 121,440

CLINTON ST.

NORTH ST.

RAMP ST-CN
AM 880
PM 880
AWDT 12,860

RAMP CS-CT
AM 840
PM 950
AWDT 11,880

RAMP SA-CT
AM 1670
PM 2120
AWDT 22,020

SUMNER TUNNEL

RAMP CN-SA
AM 2380
PM 1830
AWDT 22,070

CANB
AM 6690
PM 8020
AWDT 106,120

CALLAHAN TUNNEL

STATE STREET

CAUSEWAY STREET

2010 FORECASTED TRAFFIC
VOLUMES BASED ON 11/01/90
CA/T TRANPLAN DATA

FIGURE 2

PROPOSED ACTION
DESIGN CONTRACT D015A PROJECT ALIGNMENT
MAJOR FACILITIES TRAFFIC VOLUME FORECAST
YEAR 2010

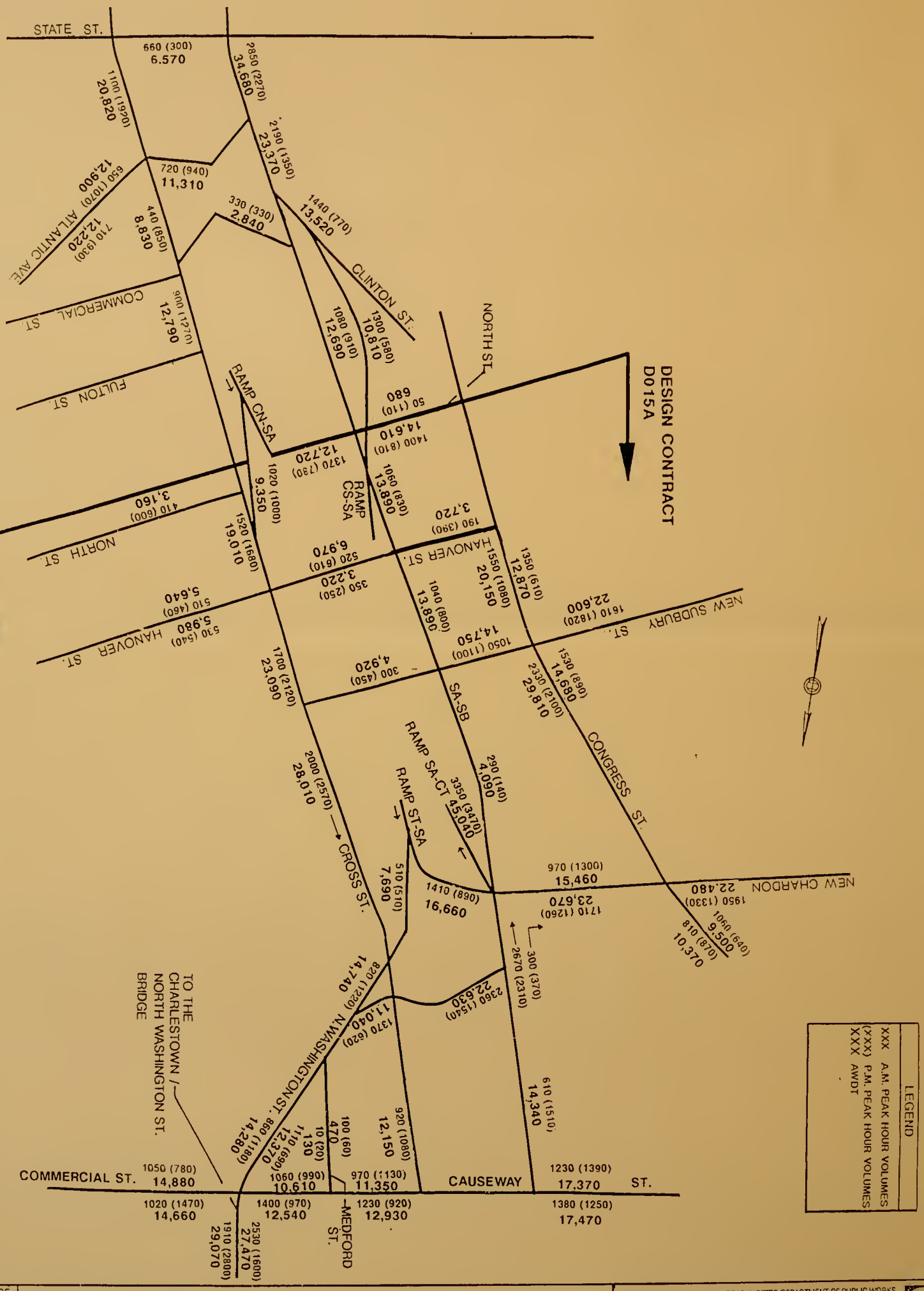


FIGURE 3

PROPOSED ACTION
DESIGN CONTRACT D015A
SELECTED ROADWAY FORCASTED PEAK HOUR
AND AWDT VOLUMES - YEAR 2010

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT

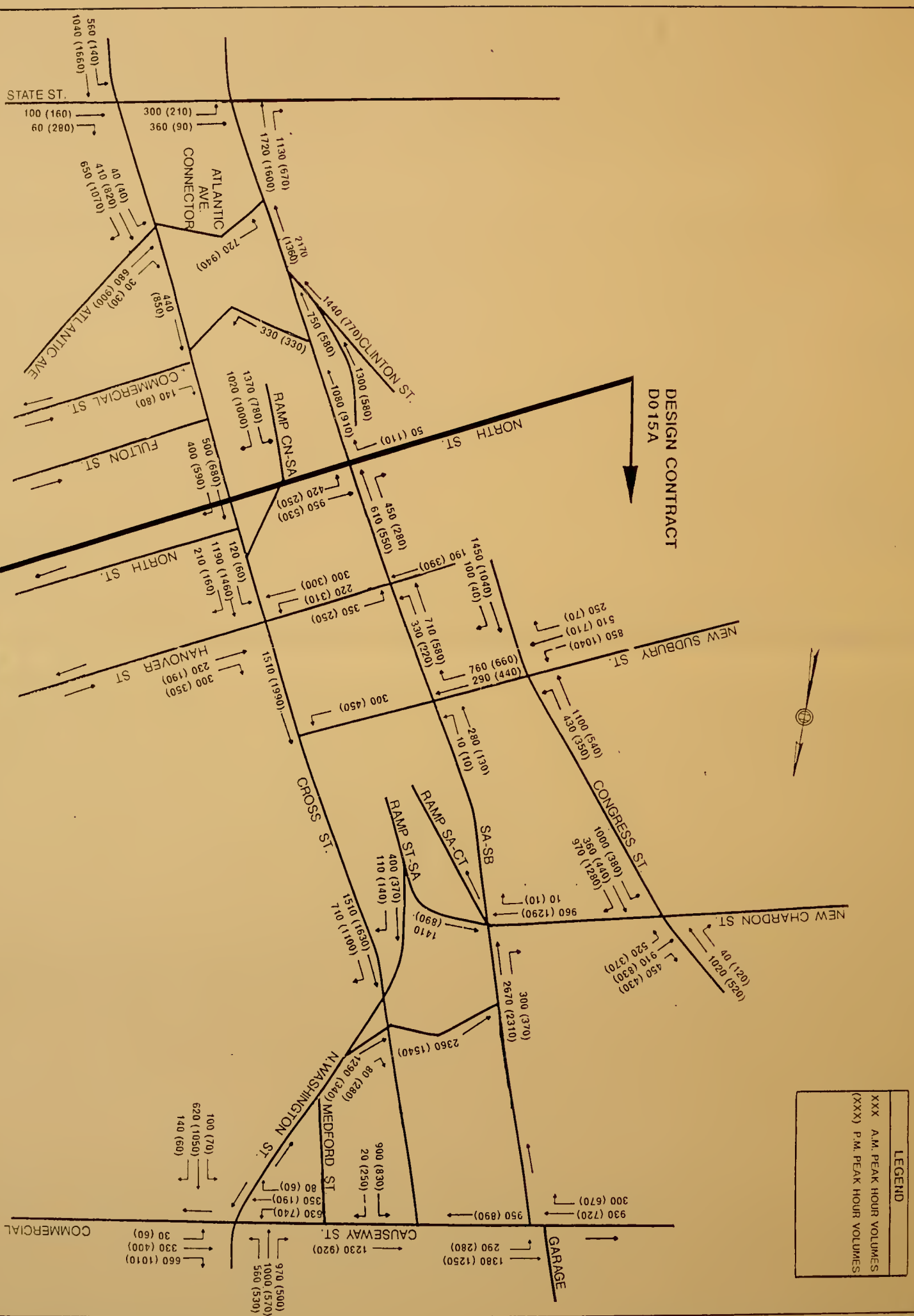


FIGURE 4

PROPOSED ACTION
DESIGN CONTRACT D015A
PEAK HOUR INTERSECTION TURNING MOVEMENT VOLUMES
YEAR 2010

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT

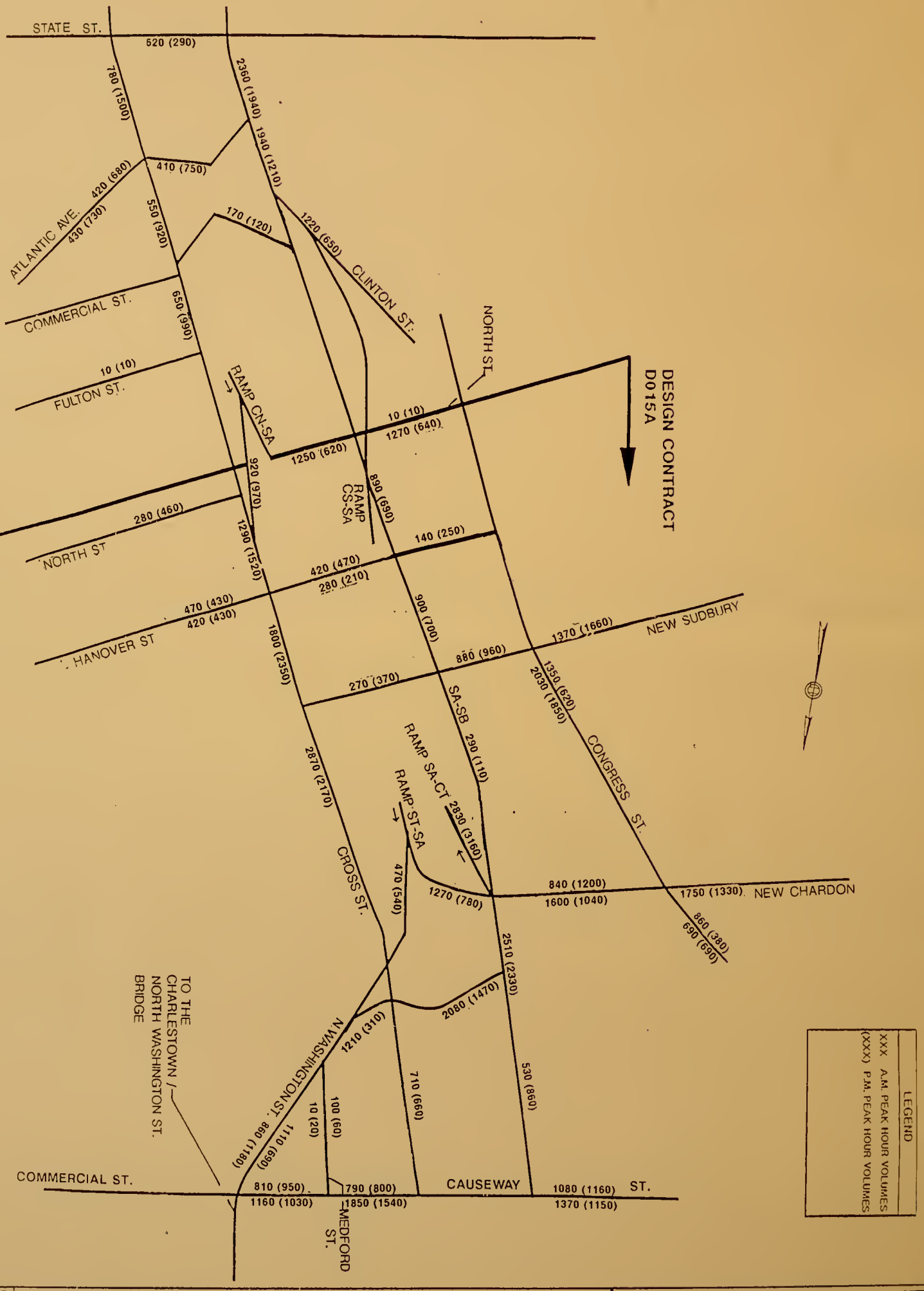


FIGURE 5

PROPOSED ACTION
DESIGN CONTRACT D015A
SELECTED ROADWAY FORCASTED PEAK HOUR VOLUMES
YEAR 1998

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT

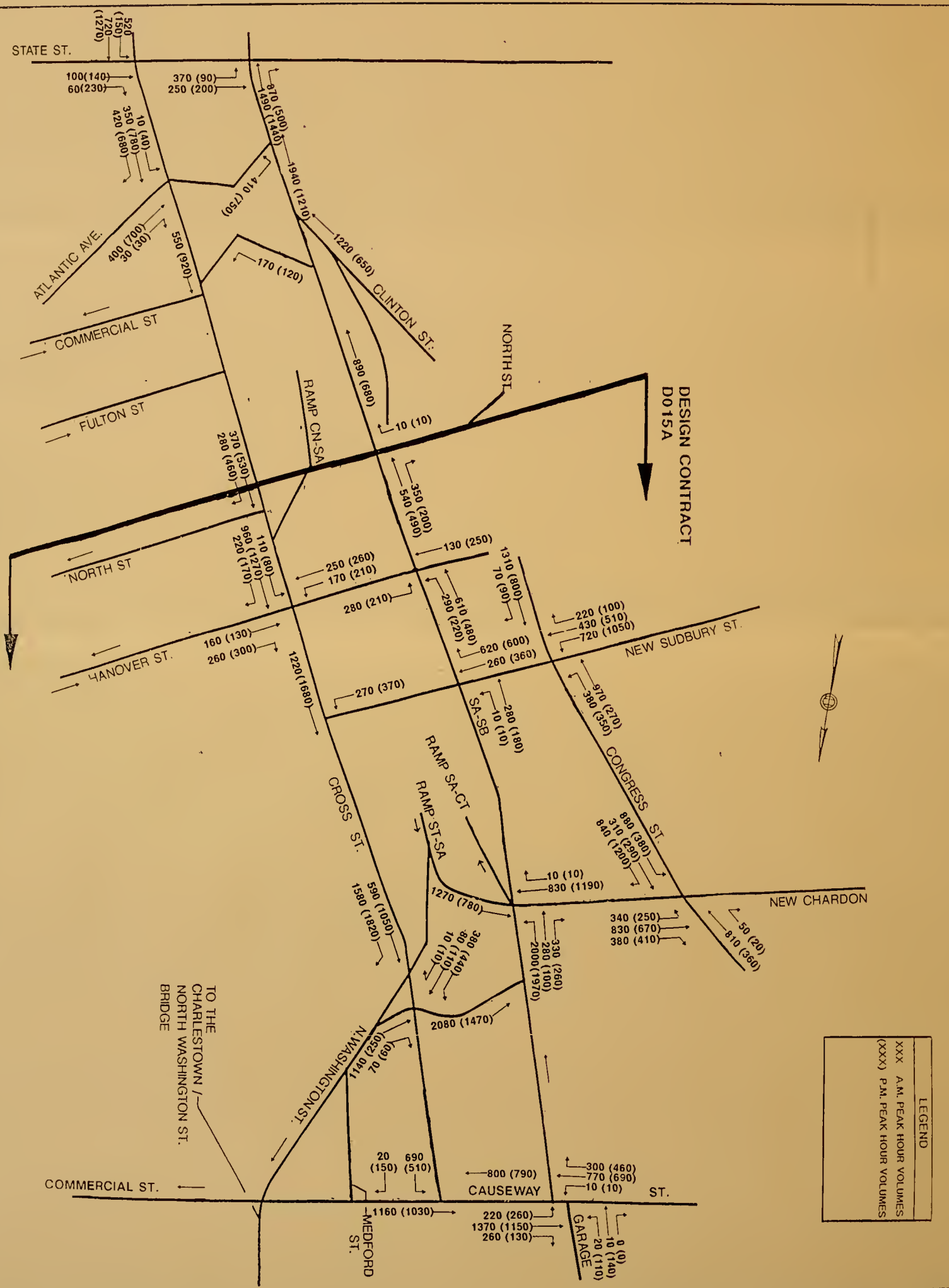


FIGURE 6

PROPOSED ACTION
DESIGN CONTRACT DO15A
PEAK HOUR INTERSECTION TURNING MOVEMENT VOLUMES
YEAR 1998

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT

16.0 Environmental Issues

Environmental issues associated with the construction of the Central Artery (I-93) mainline and ramps are discussed in the Final Supplemental Environmental Impact Statement/Report (FSEIS/R). Additionally, the Supportive Engineering Report (SER), an appendix to the FSEIS/R, discusses this section of the project in more detail in Chapter 3, Central Area. Chapter 3 (SER) provides information on utility relocations and right-of-way, geotechnical issues, tunnel ventilation and construction sequencing. Massachusetts Department of Public Works commitments affecting design and/or construction of this section of the Central Artery are summarized below. Those commitments must be reflected in appropriate contractual documents and must be implemented.

The Central Artery in this area will be a continuous tunnel network, inclusive of I-93 mainline roadways and various ramps which provide connections to surface roadways and to the Sumner and Callahan tunnels. Northbound, southbound, and interconnection traffic will be accommodated within separate unidirectional tunnel boxes, one to five lanes wide.

Ventilation building #4 will be a component of a planned multi-use facility on Parcel 7, but all functional elements of the ventilation system will be located entirely below grade. Exhaust shafts and fresh air intakes will be integral to the commercial superstructure above.

Therefore, major environmental issues associated with below grade roadway and building construction are tunnel construction techniques, excavated materials transport and disposal, and maintenance of surface activities. Major underlying objectives respecting maintenance of surface arteries are:

- To retain, essentially, full use of the existing Central Artery lanes until the Artery tunnel is completed; to replace movements with temporary ramps before they are closed, insofar as possible.

- To retain, essentially, full use of the existing Surface Artery, Atlantic Avenue and side streets by decking over tunnel sections.

- To retain use of the Sumner and Callahan tunnels during construction and to tie the tunnels into the new Artery tunnel after the opening of the Third Harbor Tunnel.

16.1 Excavation Methods

Tunnels are the principal type of structures to be built in this contract area. Tunnel sections will be primarily constructed using cut-and-cover methods with slurry wall or soldier pile tremie concrete support walls. Cut-and-cover tunnel construction involves excavation of earth materials

between roughly parallel support walls, in-place tunnel structure construction, backfilling and surface restoration.

The following Department commitments concerning construction excavation methods are made in the FSEIS/R:

- To support excavations and structures with bracing and shoring methods designed to resist lateral pressures caused by soils and groundwater loadings and surcharges from adjacent structures in the clay and fill materials encountered.

- To monitor excavation support walls and structural movements through an instrumentation and field survey program designed to record unusual deformation patterns and trigger pre-planned remedial measures, as needed.

- To hold construction contractors responsible for cosmetic damages incurred during construction, and to conduct pre-construction surveys to determine baseline conditions.

16.2 Transportation and Disposal of Excavated Materials

Transportation of excavated materials from the contract area will be by truck over the project right-of-way or temporary haul roads, to the extent possible. Delivery of materials to final disposal locations will require use of either truck, rail and/or barge:

- To transport materials suitable for marine disposal to Drydock #3 in the Boston Marine Industrial Park (BMIP) in South Boston

- To transport historic fill, unsuitable for beneficial reuse, to Commonwealth Flats in South Boston for disposal within the project right-of-way over construction haul roads

- To beneficially reuse suitable historic fill, till and marine clays for project backfill, daily landfill cover or capping, as appropriate

- To reclaim excavated materials (especially metals, brick and concrete) as possible based on cost/logistical considerations

- To use ten-wheel dump trucks to move material on a three-shift-per-day basis during peak construction periods

- To remove any hazardous material, previously identified, in advance of project construction by the Department's Right-Of-Way Assessment and Remediation Services (ROWARS) consultant to appropriate disposal locations

- To develop a comprehensive set of operational procedures to

guide the Department and its contractors in the conduct of assessment, characterization, design and remediation under M.G.L. Chapter 21 E (i.e., Massachusetts Oil and Hazardous Material Release Prevention and Response Act).

16.3 Mitigation Commitments

The Department has made the following additional commitments:

- To employ special tunnel protection measures at Parcel 7 for the MBTA Green and Orange Lines
- To consider use of noise abatement measures for areas or land uses where traffic-related noise substantially exceeds existing noise levels
- To consider use of alternative traffic routes and various demand management measures for downtown commuter traffic
- To prohibit delivery truck idling during inactive periods and to study off-peak truck deliveries for this contract area
- To mitigate fugitive dust emissions with traditional control measures, and to employ special controls for asbestos and lead-based paint emissions
- To develop specifications for maintenance of pedestrian circulation in construction contracts
- To make temporary construction design elements as compatible as possible with physical surroundings and to involve neighborhood residents in review and comment opportunities
- To require contractors to maintain clean work environments during construction
- To implement rodent, cockroach and odor control programs for the contract area
- To institute a program to identify and consider measures to address unanticipated events during construction and to monitor relevant construction and environmental activities
- To establish joint development and historic preservation guidelines for the commercial development at Parcel 7
- To conduct Phase III archaeological investigations at three sites near the North End to retrieve significant historical information which will be reviewed by the public and the State Historic Preservation Officer before project construction.

16.4 Environmental Permits

Permits, approvals and/or reviews may be required for the contract area tunnels, utility work and ventilation buildings. The Section Design Contractor's role will be to provide necessary technical information for permit applications. Those applications will be prepared by a subcontractor to the management consultant. Needed permits, approvals and/or reviews may include:

- A Sewer System Extension and Connection Permit from the Massachusetts Department of Environmental Protection (DEP), Division of Water Pollution Control (DWPC), in coordination with the Boston Water and Sewer Commission (BWSC), to authorize new storm drainage or sanitary sewer systems

- A Federal Consistency Review from the Massachusetts Coastal Zone Management Agency

- A Chapter 91 License from the DEP, Division of Wetlands and Waterways Regulation (DWWR) for construction in historic filled tidelands

- Various additional permits, approvals or reviews from the City of Boston. These include special permits from BWSC for various kinds of water and hydrant connections, dewatering of excavations (if necessary), and related matters; and a construction management plan for the Boston Transportation Department.

17.0 Construction Staging and Schedule

Construction Sequencing

17.1 Assumptions

- All six lanes of the existing Central Artery will remain open until the new depressed Artery is completed. On- and off-ramp movements will be replaced with temporary ramps before they are closed, wherever possible.

- By decking over the proposed tunnel sections, the Surface Artery below the existing Central Artery as well as Atlantic Avenue and all cross streets in the Central Area also will remain open to the maximum extent possible.

- The Sumner and Callahan Tunnels remain open during construction, and final tie-in work in the portal areas will not take place until the new Third Harbor Tunnel is open.

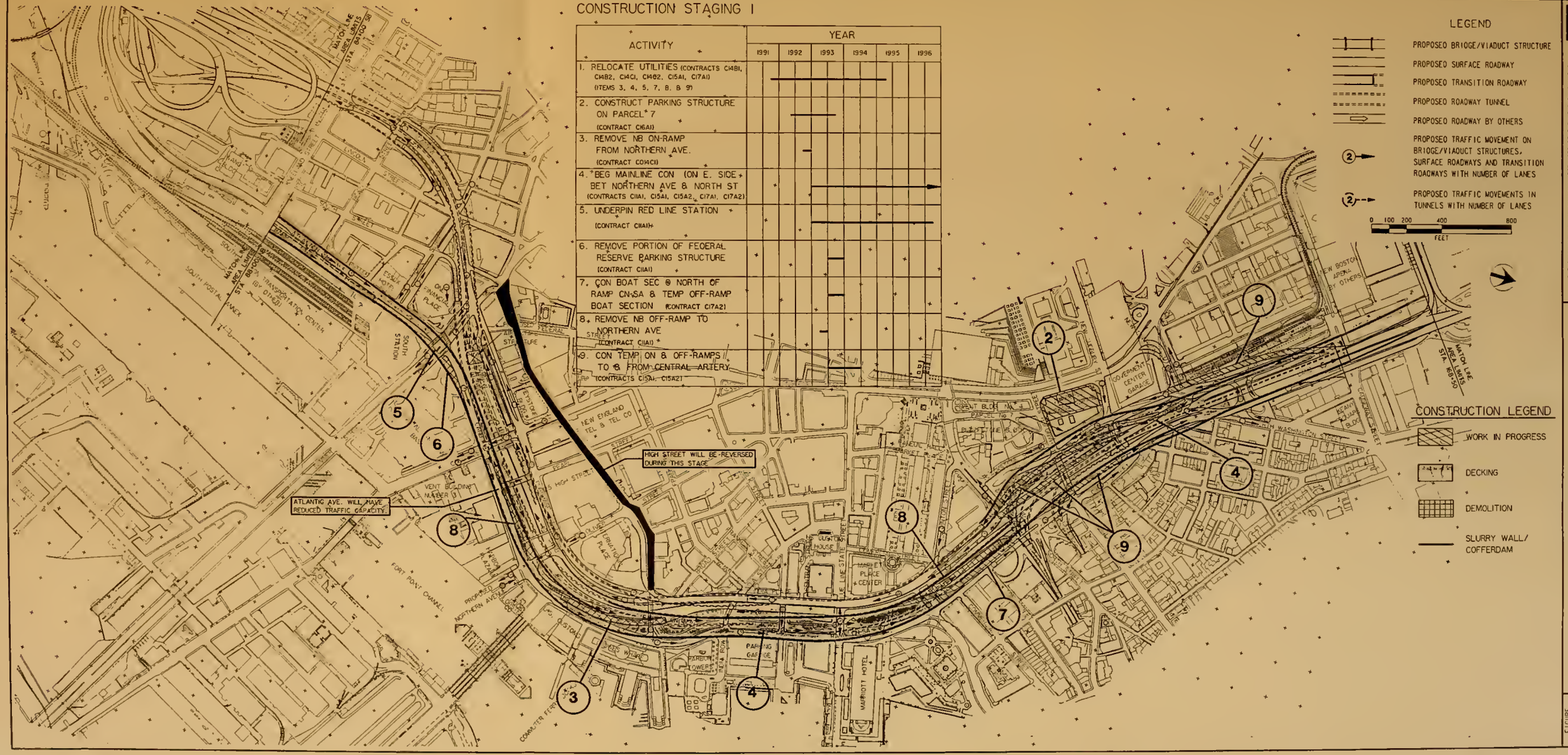
17.2 Selected Methods and Techniques

Tunnels are the principal types of structures to be built in the Central Area. The tunnel sections will be constructed primarily by the cut-and-cover method with slurry wall or soldier pile tremie concrete (SPTC) support walls. The existing elevated Central Artery will be underpinned by placing transverse beams on intermediate caisson supports between slurry walls or bear directly on the slurry or SPTC walls. Longitudinally oriented transfer beams supported by the transverse beams will attach to and support the Artery columns. The Red Line South Station tunnel will be underpinned using a jacked-pipe roof method. At the intersection of the Blue Line tunnel and the proposed mainline tunnel, the latter will be supported on drilled caissons constructed on both sides of the Blue Line tunnel. The caissons will support the weight from the proposed tunnel segment crossing and prevent damage to the existing Blue Line tunnel. The work at the Blue Line crossing will be accomplished by the MBTA during their contract to remodel and expand service at the MBTA Aquarium Station.

17.3 Maintenance of Traffic/Construction Staging

17.3(a) Stage 1 (See Figure 3.25)

Early construction activities in the Central Area will consist of the relocation of certain utilities, the construction of the parking structure on Parcel 7, and construction of the two barge loading facilities for marine disposal of excavated materials at the Fort Point Channel and Charles River sites. Utility relocation work in Atlantic Avenue will entail the removal of the northbound on-ramp from Northern Avenue to permit maintenance of surface traffic around the construction area. Mainline tunnel construction will begin on the east side of the Artery corridor between Northern Avenue and North Street, and on both sides between North and Causeway Streets. Work will include excavation support construction; surface decking installation; underpinning the Central Artery, transit facilities, and adjacent structures; temporary ramp relocations;


CONSTRUCTION STAGING I
ACTIVITY
YEAR
1991
1992
1993
1994
1995
1996
1. RELOCATE UTILITIES (CONTRACTS C14B1, C14B2, C14C1, C14G2, C15A1, C17A1) (ITEMS 3, 4, 5, 7, 8, & 9)
2. CONSTRUCT PARKING STRUCTURE ON PARCEL 7 (CONTRACT C16A1)
3. REMOVE NB ON-RAMP FROM NORTHERN AVE. (CONTRACT C01C1)
4. BEG MAINLINE CON (ON E. SIDE) BET NORTHERN AVE & NORTH ST (CONTRACTS C11A1, C15A1, C15A2, C17A1, C17A2)
5. UNDERPIN RED LINE STATION (CONTRACT C11A1)
6. REMOVE PORTION OF FEDERAL RESERVE PARKING STRUCTURE (CONTRACT C11A1)
7. CON BOAT SEC @ NORTH OF RAMP CN-SA & TEMP OFF-RAMP BOAT SECTION (CONTRACT C17A2)
8. REMOVE NB OFF-RAMP TO NORTHERN AVE (CONTRACT C11A1)
9. CON TEMP ON & OFF-RAMPS TO & FROM CENTRAL ARTERY (CONTRACTS C15A1, C15A2)
LEGEND
PROPOSED BRIDGE/VIADUCT STRUCTURE
PROPOSED SURFACE ROADWAY
PROPOSED TRANSITION ROADWAY
PROPOSED ROADWAY TUNNEL
PROPOSED ROADWAY BY OTHERS
PROPOSED TRAFFIC MOVEMENT ON BRIDGE/VIADUCT STRUCTURES, SURFACE ROADWAYS AND TRANSITION ROADWAYS WITH NUMBER OF LANES
PROPOSED TRAFFIC MOVEMENTS IN TUNNELS WITH NUMBER OF LANES
0 100 200 400 800
FEET
CONSTRUCTION LEGEND
WORK IN PROGRESS
DECKING
DEMOLITION
SLURRY WALL/ COFFERDAM
HIGH STREET WILL BE REVERSED DURING THIS STAGE
ATLANTIC AVE. WILL HAVE REDUCED TRAFFIC CAPACITY
MAJOR LINE AREA LIMITS STA 84+00 SB
MAJOR LINE AREA LIMITS STA 88+50
SOUTH STATION
SOUTH POSTAL ANNEX
TRANSPORTATION CENTER (BY OTHERS)
FEDERAL RESERVE BUILDING
FINANCIAL PLACE
NEW ENGLAND TEL & TEL CO
HIGH STREET
ATLANTIC AVENUE
VENT BUILDING NUMBER (1)
FORT POINT CHANNEL
PROPOSED NORTHERN AVENUE BRIDGE
COMMUTER FERRY
HARBOR TOWERS
PARKING GARAGE
MARRIOTT HOTEL
CUSTOM HOUSE
MARKET PLACE CENTER
RED LINE STATION
PARCEL 10
PARCEL 7
GOVERNMENT CENTER GARAGE
NEW BOSTON AVENUE (BY OTHERS)
CAUSEWAY STREET
NORTH STATION
1
2
3
4
5
6
7
8
9

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SEIS/R SUPPORTIVE ENGINEERING REPORT

Central Area
Construction Stage 1

FIGURE 17.1

excavation and bracing; and tunnel construction. Removal of a portion of the Federal Reserve Building parking structure to permit construction of the northbound tunnel just north of Summer Street also will be performed during this stage.

Temporary replacement ramps will be constructed at the following locations: the northbound off-ramp to the Callahan Tunnel, the northbound on-ramp from the Sumner Tunnel, the southbound off-ramp to New Chardon Street, the southbound on-ramp from New Sudbury Street, the southbound off-ramp to North Street, and southbound on-ramp from Causeway Street. The Northbound off-ramp to Causeway Street will be removed during this stage.

17.3(b) Stage 2 (See Figure 3.26)

Operation of the barge loading facilities will continue. Following the opening of the temporary replacement ramps indicated in Stage 1, the following ramps will be removed to clear the area for tunnel construction: the northbound off-ramp to the Callahan Tunnel, the northbound on-ramp from the Sumner Tunnel, the southbound off-ramp to New Chardon Street, the southbound on-ramp from Causeway Street, the southbound on-ramp from New Sudbury Street, and the southbound off-ramp to North Street.

Following decking of the east side of the Artery corridor, traffic will be shifted from the Surface Artery to Atlantic Avenue, and slurry wall construction, underpinning of the west side of the existing Artery, and surface decking on the west side will begin. Mainline tunnel construction will continue (below decking on the east side).

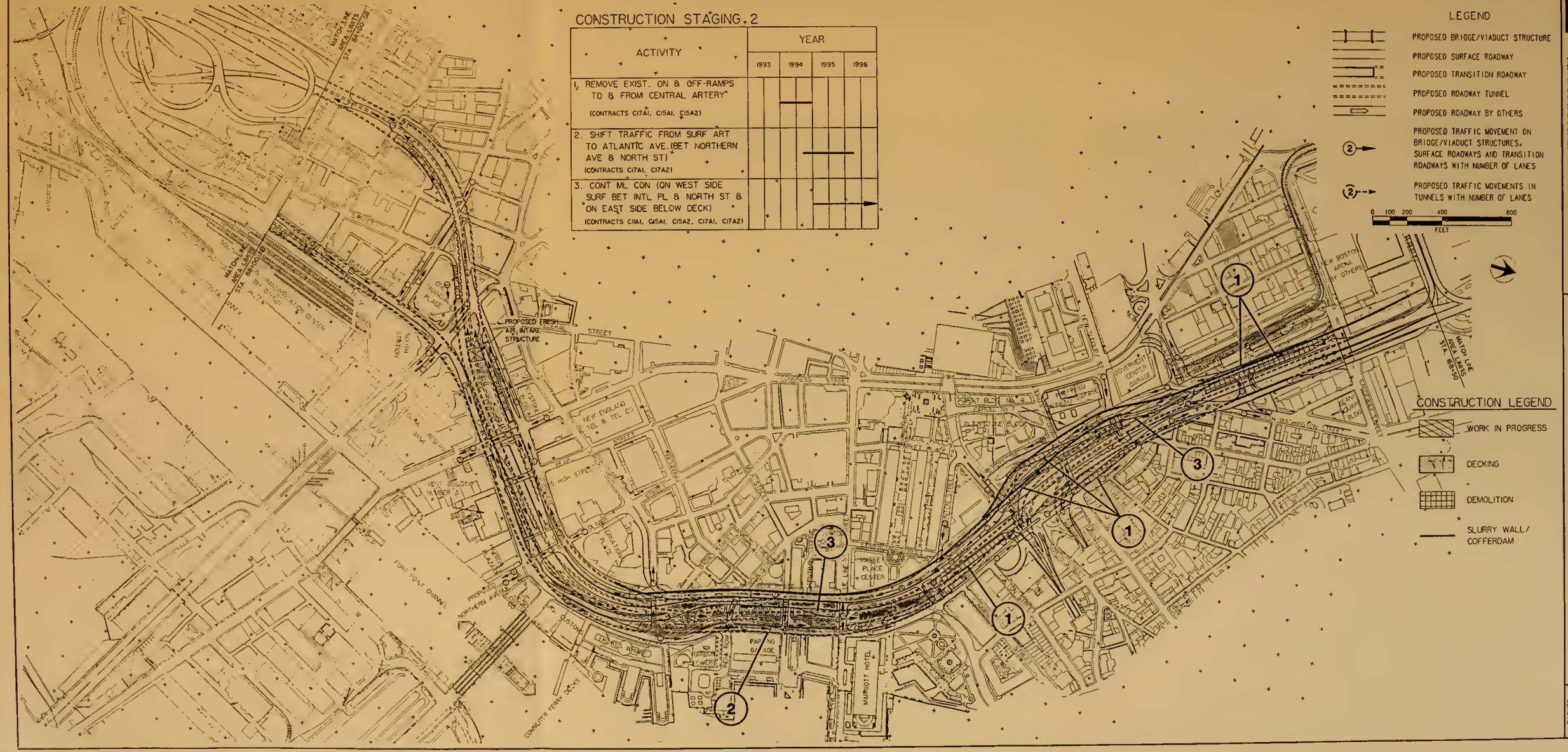
17.3(c) Stage 3 (See Figure 3.27)

Operation of the barge facilities will continue. Tunnel construction, including the northbound off-ramp CN-SA, the northbound on-ramp ST-CN, and the northbound on-ramp A-CN will be in full progress with concentration on the northbound side. Construction of ventilation building 3 and 4 will be initiated.

Construction of portions of southbound off-ramps CS-CT, CS-SA, and CS-P and on-ramps SA-CS and SA-CT will be under construction. As the northbound roadway nears completion later in this stage, one-half of the Sumner Tunnel approach will be closed and reconstructed to complete its connection to the new northbound roadway. In addition, the temporary northbound off-ramp to the Callahan Tunnel will be removed to enable the opening of the CN-SA ramp when the northbound roadway is opened.

17.3(d) Stage 4 (See Figure 3.28)

Traffic will be diverted to the new depressed Central Artery northbound, while Artery southbound traffic will be moved to the northbound side of the existing roadway south of North Street.



THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SEIS/R SUPPORTIVE ENGINEERING REPORT

Central Area
Construction Stage 2

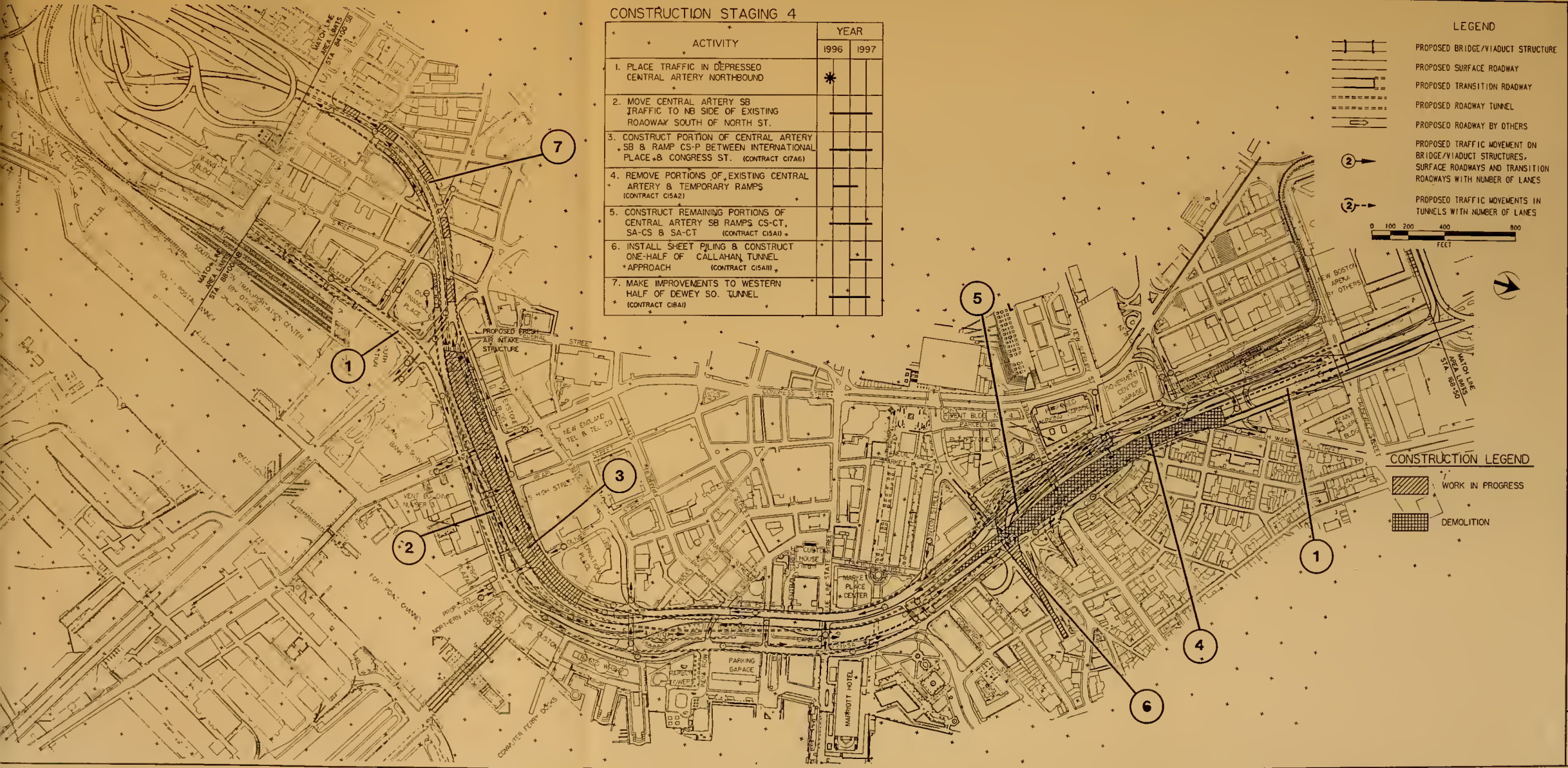
FIGURE 17.2

CONSTRUCTION STAGING 3
ACTIVITY
YEAR
1993
1994
1995
1996
1997
1998
1. EXCAVATE FOR TUNNEL (CONTRACTS C01IA1, C01SA1, C01SA2, C017A1, C017A2)
2. CONSTRUCT TUNNEL (CONTRACTS C01IA1, C01SA1, C01SA2, C017A1, C017A2)
3. CONSTRUCT VENTILATION BLDGS. No. 3 & No. 4 (CONTRACTS C01SA5, C017A5)
4. COMP. SURF. DECKING (BETWEEN INT. PLACE & CAUSEWAY ST.) (CONTRACTS C01SA1, C01SA2, C017A2)
5. REMOVE NB OFF-RAMP TO CAUSEWAY STREET (CONTRACT C01SA2)
6. CONSTRUCT CENTRAL ARTERY NB OFF-RAMP CN-SA & ON-RAMP ST-CN (CONTRACTS C01SA1, C017A2)
7. CONSTRUCT CENTRAL ARTERY NB ON-RAMP A-CN (CONTRACT C017A1)
8. CON POR OF CASB, OFF-RAMPS CS-ST CS-SA, CS-P & ON-RAMPS SA-CS, SA-CT (CONTRACTS C01SA1, C017A2)
9. INST. SHEET PIL. & CON. ONE HALF OF SUMNER TUNNEL APPROACH (CONTRACT C01SA1)
10. REMOVE TEMP. CENTRAL ARTERY NB OFF-RAMP TO CALLAHAN TUNNEL (CONTRACT C017A2)
LEGEND
PROPOSED BRIDGE/VIADUCT STRUCTURE
PROPOSED SURFACE ROADWAY
PROPOSED TRANSITION ROADWAY
PROPOSED ROADWAY TUNNEL
PROPOSED ROADWAY BY OTHERS
PROPOSED TRAFFIC MOVEMENT ON BRIDGE/VIADUCT STRUCTURES, SURFACE ROADWAYS AND TRANSITION ROADWAYS WITH NUMBER OF LANES
PROPOSED TRAFFIC MOVEMENTS IN TUNNELS WITH NUMBER OF LANES
0 100 200 400 800
FEET
CONSTRUCTION LEGEND
WORK IN PROGRESS
DECKING
DEMOLITION
NORTH STATION
SOUTH STATION
PROPOSED FRESH AIR INTAKE STRUCTURE
FORT POINT CHANNEL
PROPOSED NORTHERN AVENUE BRIDGE
COMMUTER FERRY DOCKS
CUSTOM HOUSE
MARRIOTT HOTEL
GOVERNMENT CENTER GARAGE
NEW BOSTON AIRSPACE BY OTHERS
MATCH LINE AREA LIMITS STA 88+50
MATCH LINE AREA LIMITS STA 84+00 SB

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SEIS/R SUPPORTIVE ENGINEERING REPORT

Central Area
Construction Stage 3

FIGURE 17.3


CONSTRUCTION STAGING 4
ACTIVITY
YEAR
1996
1997
1. PLACE TRAFFIC IN DEPRESSED CENTRAL ARTERY NORTHBOUND
2. MOVE CENTRAL ARTERY SB TRAFFIC TO NB SIDE OF EXISTING ROADWAY SOUTH OF NORTH ST.
3. CONSTRUCT PORTION OF CENTRAL ARTERY SB & RAMP CS-P BETWEEN INTERNATIONAL PLACE & CONGRESS ST. (CONTRACT C17A6)
4. REMOVE PORTIONS OF EXISTING CENTRAL ARTERY & TEMPORARY RAMPS (CONTRACT C15A2)
5. CONSTRUCT REMAINING PORTIONS OF CENTRAL ARTERY SB RAMPS CS-CT, SA-CS & SA-CT (CONTRACT C15A1)
6. INSTALL SHEET PILING & CONSTRUCT ONE-HALF OF CALLAHAN TUNNEL APPROACH (CONTRACT C15A11)
7. MAKE IMPROVEMENTS TO WESTERN HALF OF DEWEY SQ. TUNNEL (CONTRACT C18A1)
LEGEND
PROPOSED BRIDGE/VIADUCT STRUCTURE
PROPOSED SURFACE ROADWAY
PROPOSED TRANSITION ROADWAY
PROPOSED ROADWAY TUNNEL
PROPOSED ROADWAY BY OTHERS
PROPOSED TRAFFIC MOVEMENT ON BRIDGE/VIADUCT STRUCTURES, SURFACE ROADWAYS AND TRANSITION ROADWAYS WITH NUMBER OF LANES
PROPOSED TRAFFIC MOVEMENTS IN TUNNELS WITH NUMBER OF LANES
0 100 200 400 800
FEET
CONSTRUCTION LEGEND
WORK IN PROGRESS
DEMOLITION
PROPOSED FRESH AIR INTAKE STRUCTURE
MATCH LINE AREA IMPTS STA 84+00 SB
MATCH LINE AREA IMPTS STA 160+50
SOUTH BOSTON TRANSPORTATION CENTER (BY OTHERS)
NEW BOSTON AREA (BY OTHERS)
NEW ENGLAND TEL & TEL CO
VENT BUILDING NUMBER 8
VENT BUILDING NUMBER 7
CUSTOM HOUSE
MARKET PLACE CENTER
PARKING GARAGE
MARRIOTT HOTEL
HARBOR TOWER
CONGRESS STREET
HIGH STREET
PROPOSED NORTHERN AVENUE BRIDGE
COMMUTER FERRY DOCKS
1
2
3
4
5
6
7

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SEIS/R SUPPORTIVE ENGINEERING REPORT

Central Area
Construction Stage 4

FIGURE
17.4

With the traffic diverted, construction of the transition portion of the southbound roadway, including Ramp CS-P, between International Place and Congress Street, will be initiated. Improvements to the western half of the Dewey Square tunnel will also be performed. Ramp A-CN will be opened at this time.

Portions of the existing Artery and temporary ramps no longer in service will be removed. The remaining portions of southbound Ramps CA-SB, CS-CT, SA-CS, and SA-CT will be constructed. Also, the Callahan Tunnel approach will be constructed to complete the CS-CT connection.

17.3(e) Stage 5 (See Figure 3.29)

Traffic will be diverted to the new depressed Central Artery southbound and the western half of the Dewey Square tunnel. With traffic now on this side of the Dewey Square tunnel and transition segment, the remainder of the southbound tunnel, including counterflow Ramp R-T and improvements to the east side of the Dewey Square tunnel will be completed. With all traffic off the existing elevated artery, the remainder of the existing structure, including underpinning supports and temporary ramps can be removed. Following removal, tunnel backfill and surface restoration work will be performed. Barge loading facilities will be removed. Remaining ramp work, including ST-SA and RT, will be completed and the ramps opened during this stage. Following completion of the work in the Dewey Square tunnel and transition section, all remaining roadway required to complete the project will be opened.

17.4 Temporary Structures

Other than the temporary on- and off-ramps, and decking of the Surface Artery over the depressed Central Artery, no major temporary structures are anticipated.

17.5 Staging Areas

The contractors' staging and laydown areas will be located in the vicinity of the proposed alignment in the right-of-way, at 150 Causeway Street, on Metropolitan District Commission (MDC) property in the north, on Parcel 7 in the Haymarket Area, and at the Boston Edison site in the south. Fencing security, and maintenance of these areas will be the responsibility of the contractors under the supervision of the Department's management consultant. The Guilford property, discussed in Chapter 20 of the SEIS/R, also is being considered as a staging area.

CONSTRUCTION STAGING 5
ACTIVITY
YEAR
1997
1998
1. PLACEE TRAFFIC IN DEPRESSED CENTRAL ARTERY SB & WESTERN HALF OF DEWEY SQ. TUNNEL
2. CONSTRUCT EASTERN HALF OF CENTRAL ARTERY SB AT DEWEY SQ. AREA (BETWEEN INTERNATIONAL PLACE & CONGRESS ST. (CONTRACT C17A6)
3. CONSTRUCT COUNTERFLOW RAMP R-T (CONTRACTS C17A6, C18A1)
4. MAKE IMPROVEMENT & WIDEN EASTERN HALF OF DEWEY SQ. TUNNEL (CONTRACT C18A1)
5. REMOVE TEMPORARY CENTRAL ARTERY SB OFF-RAMPS (CONTRACTS C15A1, C15A2)
6. REMOVE REMAINDER OF EXISTING ELEVATED ARTERY, UNDERPINNING SUPORTS & DECKING (CONTRACTS C15A6, C17A6)
7. COMPLETE TUNNEL BACKFILL & SURFACE RESTORATION WORK (CONTRACTS C15A6, C17A6)
8. COMPLETE RAMP ST-SA (CONTRACT C15A1)
9. OPEN REMAINDER OF DEPRESSED SB CENTRAL ARTERY
10. OPEN REMAINING CENTRAL ARTERY RAMPS INCLUDING RAMPS RT & ST-SA
LEGEND
PROPOSED BRIDGE/VIADUCT STRUCTURE
PROPOSED SURFACE ROADWAY
PROPOSED TRANSITION ROADWAY
PROPOSED ROADWAY TUNNEL
PROPOSED ROADWAY BY OTHERS
PROPOSED TRAFFIC MOVEMENT ON BRIDGE/VIADUCT STRUCTURES, SURFACE ROADWAYS AND TRANSITION ROADWAYS WITH NUMBER OF LANES
PROPOSED TRAFFIC MOVEMENTS IN TUNNELS WITH NUMBER OF LANES
0 100 200 400 800
FEET
CONSTRUCTION LEGEND
WORK IN PROGRESS
DEMOLITION
MATCH LINE AREA LIMITS STA. 84+00 SB
MATCH LINE AREA LIMITS STA. 88+00 SB
MATCH LINE AREA LIMITS STA. 468+50
SOUTH POSTAL ANNEX
SOUTH STATION TRANSPORTATION CENTER
SOUTH STATION
PROPOSED FRESH AIR INTAKE STRUCTURE
FINANCIAL PLACE
DEWEY SQUARE
NEW ENGLAND TEL & TEL CO
VENT BUILDING NUMBER 7
FORT POINT CHANNEL
PROPOSED NORTHERN AVENUE
COMMUTER FERRY DOCKS
CUSTOM HOUSE TOWER
CUSTOM HOUSE
STATE STREET
MARKET PLACE CENTER
PARKING GARAGE
MARRIOTT HOTEL
GOVERNMENT CENTER GARAGE
NEW BOSTON ARENA (BY OTHERS)
KEANSBURY BLDG
WASHINGTON STREET
CONGRESS STREET
1
2
3
4
5
6
8
9

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT
SEIS/R SUPPORTIVE ENGINEERING REPORT

Central Area Construction Stage 5

FIGURE 17.5

18.0 Preliminary Construction Quantities

The D015A SDC shall be responsible for preparing construction cost estimates as outlined in the Scope of Services in Section 3.2.12 Cost Estimates and Trends.

The approximate construction costs associated with design Contract D015A and associated Construction Contracts C15A1, C15A2 and C15A3 are as follows:

Contract	Description	Cost
C15A1	I-93 Central Artery North to Chardon	$ 259,889,000
C15A2	I-93 Central Artery Chardon to Causeway	132,504,000
C15A3	I-93 Parcel 7/ Vent. Building No. 4	54,009,000
		$ 446,402,000*

*The above costs are direct construction costs and exclude contingency, right-of-way, engineering, construction management, and final surface restoration costs.

Costs shown are based on the 1991 ICE which reflect 4th Quarter 1989 Pricing.

The above costs are based on the scope known for these packages at the time of the preparation of the 1991 ICE.

APPENDIX A

(To the Preliminary Design Report)

CONSTRUCTION IMPACT MITIGATION

1.0 GENERAL

The Massachusetts Department of Public Works requires that the work of the CA/T Project be performed with as little disruption to the public as absolutely necessary.

This document is intended to provide general mitigation requirements to be considered by the Section Design Consultant during the final design effort. Site-specific mitigation requirements are described in the Preliminary Design Report.

The objective of construction impact mitigation is to minimize disruption to:

- Traffic
- Public Transportation
- Vehicular Access
- Pedestrian Access
- Parking

and, to minimize the disruption resulting from:

- vibration to adjacent buildings
- noise/air and other environmental concerns

In order to accomplish this objective, the following elements, where applicable, shall be addressed in the construction documents:

- Suggested construction sequencing that would reduce construction impacts.
- Limitation on time of construction operations.
- Available contractor laydown and use areas.
- Contractor access routes.
- Adjacent building access and operational requirements.

- Traffic maintenance requirements.

- Pedestrian access and walkway requirements.

- Localized noise/vibration sensitivities (see CA/T Conservator's Report as referenced in Article 2.7 of this document and the May 1990 Draft SEIS).

2.0 GUIDELINES

2.1 Traffic Maintenance:

The goal during construction is to maintain traffic and transportation service with minimum disruptions to the mobility of the commuting system. The construction document prepared by the SDC shall require the contractor to:

A. Implement the Traffic Management Plan developed by the SDC.

B. Identify and submit detour plans or plans of temporary decking systems to maintain necessary traffic patterns.

C. Clearly sign detours, temporary lane constrictions and closing of roads.

2.2 Transportation Alternatives:

The SDC shall be aware of all transportation alternatives which interface with the design. Many transportation alternatives are under development such as increased MBTA subway, railroad, and bus services.

2.3 Pedestrian Access and Flow:

Safe pedestrian access and flow along streets will be interrupted by construction sites. Safe continuous pedestrian flow along alternate routes must be provided. The SDC shall:

A. Identify pedestrian walkways and pedestrian entrances to buildings that must be maintained during construction.

B. Design and specify protective walkways and barriers as appropriate to each site and stage. (CA/T design standards and guidelines for walkways and barriers will be provided to the SDC.)

2.4 Vehicular Access:

Vehicular access to loading and delivery areas, pick up and drop off points, and parking facilities will be impacted and may be temporarily interrupted by construction operations. The SDC shall:

A. Identify all locations where vehicular access may be impacted by the work.

B. Obtain data pertinent to the nature of the vehicular access areas such as peak use hours, volume of vehicles, and impact of temporary disruption.

C. Indicate in the construction documents that the contractor shall identify, design, or specify temporary facilities that minimize disruptions.

D. Identify alternate locations for loading zones, delivery and passenger drop-offs, where appropriate.

2.5 Signage & Lighting:

Used as a public information tool, signs will convey information on detours, relocated pedestrian ways and altered access to business. The SDC shall:

A. Identify and note in the construction documents clear, visible locations for signs to motorists, pedestrians, rail commuters and building occupants.

B. Design adequate lighting of temporary pathways, roadways and signs for public information and safety.

C. Indicate and specify lighting requirements in the construction documents.

2.6 Parking:

Parking losses will be an unavoidable consequence of construction operations. The SDC shall:

A. Define construction boundaries to minimize disruption to parking.

B. Consider, and where appropriate, specify, methods resulting in the least possible construction impact to existing parking areas.

2.7 Historic Resources:

The SDC shall become familiar with the CA/T Historic Resource Concept Report, December 1988 and any subsequent reports produced by the Conservator for this project and design in accordance with the guidelines and requirements stated.

2.8 Building & Structure Support:

Some buildings or structures in the vicinity of construction are susceptible to effects from the construction operation. These impacts include effects attributable to ground settlement and vibrations. The SDC shall:

A. Refer to the Conservator's Report for the identification of sensitive historic buildings and structures in proximity to the proposed construction area.

B. Conduct structural analyses of any building or structure, as identified in the Preliminary Design Report, likely to be impacted by the construction operation.

C. Specify appropriate building protection methods for the affected structures.

2.9 Construction Method:

Implementation of various construction methods and techniques will have a direct bearing on the impact experienced by surrounding neighborhoods. The SDC shall:

A. Be cognizant of alternative methods for performing the work.

B. Identify locations where particular sensitivities exist and, where conditions warrant, specify suggested methods that reduce impacts.

2.10 Integrated Pest Management:

The SDC shall become familiar with the CA/T Integration Pest Management Program.

2.11 Environmental:

The SDC shall become familiar with the CA/T Environmental Impact Statement and design in accordance with the commitments stated.

2.12 Construction Arts:

A construction arts program will be an integral part of construction activities on this project. A CA/T Arts Administrator will coordinate all arts related activities for the project. Where the locations for construction arts are identified by the Management Consultant, the construction art areas shall be shown in the contract drawings, or indicated in the specifications, (e.g., provision of primed wall barriers to open ground with viewing spots).

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309	CA-PD-S-472	Bent 21: Plan/Section Stage II
310	CA-PD-S-473	Bent 21: Details Stage II
311	CA-PD-S-474	Bent 22: Plan/Section Stage I
312	CA-PD-S-475	Bent 22: Details Stage I
313	CA-PD-S-476	Bent 22: Plan/Section Stage II
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315	CA-PD-S-478	Bent 23: Plan/Section
316	CA-PD-S-479	Bent 23: Details
317	CA-PD-S-480	Bent RH1-24-RF1 Plan/Section
318	CA-PD-S-481	Bent RH1-24-RF1 Details
319	CA-PD-S-482	Bent RH2 Plan/Section
320	CA-PD-S-483	Bent RH2 Details
322	CA-PD-S-484	Bent 25-RF2 Plan/Section
323	CA-PD-S-485	Bent 25-RF2 Details
324	CA-PD-S-486	Bent RH3 Plan/Section
325	CA-PD-S-487	Bent RH3 Details
326	CA-PD-S-488	Bent RF3 Plan/Section
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328	CA-PD-S-490	Bent 26-RF4 Plan/Section
329	CA-PD-S-491	Bent 26-RF4 Details
320	CA-PD-S-492	Bent RF5 Plan/Section
330	CA-PD-S-493	Bent RF5 Details
331	CA-PD-S-494	Bent 27 Plan/Section
332	CA-PD-S-495	Bent 27 Details
333	CA-PD-S-496	Bent 28 Plan/Section
334	CA-PD-S-497	Bent 28 Details
335	CA-PD-S-498	Bent 29-RG1 Plan/Section
336	CA-PD-S-499	Bent 29-RG1 Details
337	CA-PD-S-500	Bent 30-RG2 Plan/Section Stage I
338	CA-PD-S-501	Bent 30-RG2 Details Stage I
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349	CA-PD-S-512	Bent 33 Plan/Section
350	CA-PD-S-513	Bent 33 Details
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352	CA-PD-S-515	Underpinning Temporary Ramp Details
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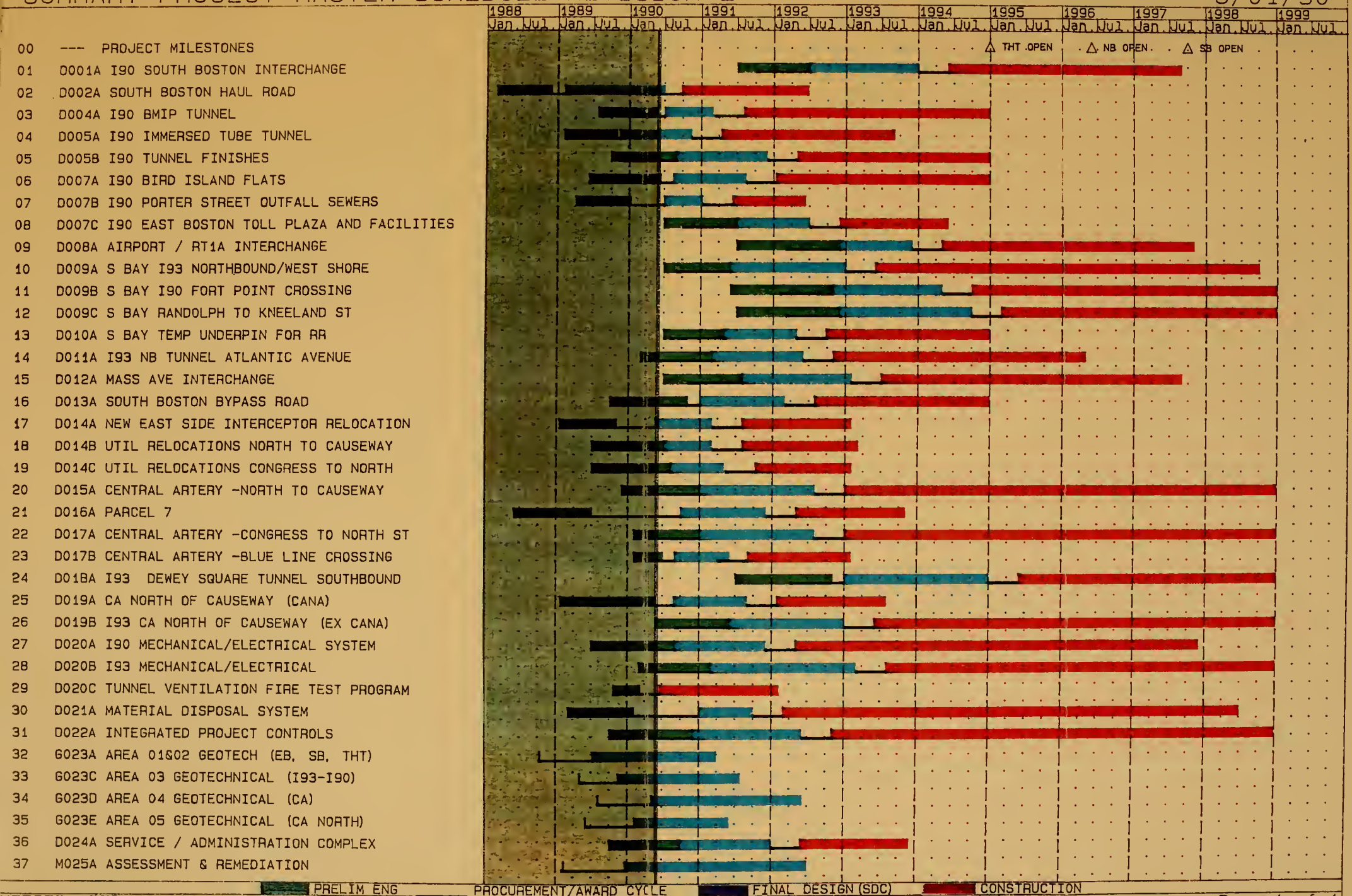
CENTRAL ARTERY (I-93) / TUNNEL (I-90) PROJECT

SUMMARY PROJECT MASTER SCHEDULE REVISION 2

6/01/90


1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999
Jan Jul
00 --- PROJECT MILESTONES
01 D001A I90 SOUTH BOSTON INTERCHANGE
02 D002A SOUTH BOSTON HAUL ROAD
03 D004A I90 BMIP TUNNEL
04 D005A I90 IMMERSED TUBE TUNNEL
05 D005B I90 TUNNEL FINISHES
06 D007A I90 BIRD ISLAND FLATS
07 D007B I90 PORTER STREET OUTFALL SEWERS
08 D007C I90 EAST BOSTON TOLL PLAZA AND FACILITIES
09 D008A AIRPORT / RT1A INTERCHANGE
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33 G023C AREA 03 GEOTECHNICAL (I93-I90)
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35 G023E AREA 05 GEOTECHNICAL (CA NORTH)
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37 M025A ASSESSMENT & REMEDIATION
THT OPEN
NB OPEN
SB OPEN
PRELIM ENG
PROCUREMENT/AWARD CYCLE
FINAL DESIGN (SDC)
CONSTRUCTION

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